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"THE ENGINEER," DECEMBER 26, 1930

With METALLURGICAL SUPPLEMENT.

The Engineer.

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Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

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The Engineer

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PATENTS

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THE PROPRIETORS of BRITISH PATENTS Nos. 7089/15, 153,867 and 194,201, relating to "Roller Bearings;" and No. 203,472, relating to "Machines for Gauging and Sorting Bearing Rollers," are DESIROUS of ENTERING into ARRANGEMENTS with British Manufacturers with a view to the SALE or COMMERCIAL EXPLOITATION of the inventions protected by the said patents.

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THE PROPRIETOR of BRITISH LETTERS PATENTS Nos. 245,716 and 245,717, both dated 10th January, 1925, for "Processes for Producing Steel," is DESIROUS of DISPOSING of the PATENT RIGHTS or of NEGOTIATING for the GRANTING of LICENCES to work thereunder.

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THE PROPRIETOR of BRITISH LETTERS PATENTS Nos. 290,317 and 290,318, both dated 5th January, 1927, for "Manufacture of Steel," is DESIROUS of DISPOSING of the PATENT RIGHTS or of NEGOTIATING for the GRANTING of LICENCES to work thereunder.

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No. 282,627 (G. Regnac-Paille), "Improvements in or connected with Melting Furnaces for Liquid Fuel;"

No. 270,974 (H. Limbourg), "Improvements in or relating to Alloys Intended as a Substitute for Platinum;"

No. 207,555 (P. Pipereaut and A. Helbronner), "Improvements in the Manufacture of Titanic and Zinc Compounds;"

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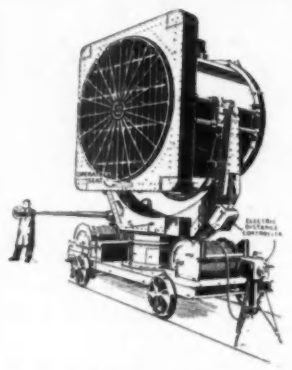

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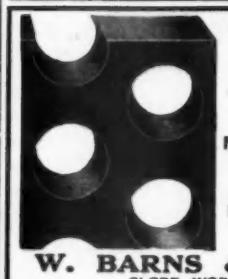

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The Metallurgist

"The Metallurgist" is a free supplement accompanying the last issue of "The Engineer" for each month.

It is devoted entirely to the science and practice of Metallurgy—ferrous and non-ferrous.

The following comments by a few of our readers indicate its usefulness in a field hitherto much neglected.

"The supplement is very well arranged and will be of considerable value to the Metallurgical Industry."—Sheffield, February, 1925.

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A Seven-Day Journal

The Opening of the Nag Hammadi Barrage.

ON Friday of last week, December 19th, the Nag Hammadi Barrage, on the river Nile, was formally opened by King Fuad. The ceremony was attended by Sir Percy Lorraine, the British High Commissioner, members of the Diplomatic Corps, and many Government guests. The King arrived at 10 o'clock in the royal yacht "Khassed Kheir," and after a speech by the Egyptian Minister of Public Works, His Majesty unveiled a tablet to commemorate the event, afterwards starting the mechanism for operating the sluice gates. He then passed through the lock in his yacht. We described this barrage in some detail in our issue of September 2nd, 1927, just before constructional work was begun, and we propose in a subsequent issue to give further particulars regarding the progress of the undertaking.

Dry Docking Accommodation at Greenock.

AT a meeting held on Thursday last, December 18th, the Greenock Harbour Trust, gave its approval, subject to the legal arrangements and an Exchequer grant of 90 per cent. of the wages of the unemployed men required for the work, to a scheme for improving the Garvel graving dock. It is proposed that the existing obsolete entrance to the dock shall be reconstructed so that modern ships can use the dock without difficulty. The new entrance is to have perpendicular sides 70ft. apart and a sill with a minimum depth of 29ft. 6in. below high-water at ordinary spring tides. The gates are to be of the steel leaf type, and will be operated by electric winches. The whole of the work necessary is expected to cost about £26,000, and the balance of the cost, after deduction of the Government grant, is to be reimbursed to the Harbour Trust by the Greenock Dockyard Company, Ltd. That company is to be given exclusive use of the dock for a period of fifteen years after the completion of the alterations, and it will also be free of all rent and rates on the ships placed by it in the dock. It is well known that the Clan Line is closely associated with the Greenock Dockyard Company, Ltd., and it is expected that the new facilities will establish an important centre for ship repairing on the Clyde.

Research in the Printing Industry.

THE latest research association to be formed under the scheme of the Department of Scientific and Industrial Research is one designed to serve the needs of the printing industry in all its branches. Apart from the actual setting of the type and the pulling of impressions therefrom, the printing industry depends upon the labours and achievements of the type-founder—or his modern equivalent, the manufacturer of composing machines—the papermaker, the ink manufacturer, and the block maker. All these branches of activity will be represented in the new research association, and much will, no doubt, be gained by a co-ordinated study of the relationship of the different branches and of their joint effect on the final product—the printed book or newspaper, as sold to the public. It is not intended that the association should at the outset establish its own laboratories. The research work required will be conducted in the laboratories, already existing, which specialise in the particular subjects to be dealt with. The work of the association will, to begin with, at least, be confined to the collection and dissemination of information to the members and to the direction of scientific investigations under the general care of a qualified officer. A meeting in furtherance of the objects of the association is to be held at Stationers' Hall, E.C. 4, on January 2nd, at 2.30 p.m. The association has already been registered as a company, as is usual in the case of bodies of its kind formed under the Department's scheme.

The Fuel Research Board.

THE annual report, published this week, of the Fuel Research Board, contains the announcement of a certain reduction in the attention which, for several years, has been paid at the Fuel Research Station to the development of low-temperature carbonisation processes. Much, it is admitted, remains to be done if the process is to live and gather momentum, but the time has now arrived, it is contended, when the high degree of priority given to the development of full-size retorts for low-temperature carbonisation can no longer be justified. The basis for this change of attitude is not very clearly indicated. It would appear, however, to be, in part at least, an outcome of the fact that in recent years the world prices for fuel oils of all sorts have fallen so much that the economic position of low-temperature carbonisation processes has altered very much for the worse. The saleable products of the process are gas, tar and coke. At the present prices obtainable for tar, the report significantly remarks, it is necessary to dispose of at least one, and preferably both, of the other products at a price per therm considerably higher than the price per therm paid for the coal. If low-temperature carbonisation has gone down in the Board's scale of priority, pulverised fuel for marine and land purposes has gone up. So far, pulverised fuel for land purposes has been generally associated with very large combustion spaces. The Board considers that there is no scientific necessity for such large spaces and is increasing the attention which it is paying to the development of short-flame burners. The hydrogenation of coal would appear to have suffered neither a diminution nor an advancement of priority. Experiments on a small and intermediate scale have been continued. In particular the use of catalysts is being studied and some interesting results have been obtained.

Low Temperature Carbonisation.

THE remarks made by the Fuel Research Board, referred to in the earlier part of the preceding note, may usefully be supplemented by a reference to the annual report issued at the end of last week by Low Temperature Carbonisation, Ltd. The result of the company's operations during the year ended October 31st was a debit balance of £9317, which, with £4494 brought in, made a total deficit of £13,811. The year, it is stated, was very unsatisfactory from a trading point of view, largely because of a further fall in the price of by-products. Had the prices remained at the 1927–28 level, the crude oil from the 304 retorts at Barugh and Askern would have realised an additional £37,500. The fall which occurred in prices was mainly caused by changed conditions in the American creosote market. In order to meet the situation the Board has been expediting its arrangements for cracking coal oil into petrol. The first consignment of coal oil has now been cracked at the Killingholm refinery of Petroleum Refineries, Ltd., and petrol of an excellent quality has, it is stated, been produced. The better utilisation of the crude coal oil resulting from its conversion into petrol and fuel oil will, it is anticipated, result in a considerable increase of profits. All the retorts at Barugh and Askern are, it is stated, working full time and at their maximum capacity. A coalite works erected at East Greenwich for the South Metropolitan Gas Company is now practically completed. The first battery has been heated up and production will begin early in January.

The Blue Funnel Motor Ship "Ajax."

AT the end of last week Scott's Shipbuilding and Engineering Company, Ltd., safely launched the new Blue Funnel liner "Ajax," the naming ceremony being performed by Mrs. Richard Holt, of Liverpool. The "Ajax" is the nineteenth ship built for Alfred Holt and Co. by Scott's and the third in the company's fleet to bear that name. She has a length of 453ft. 6in. on the water line, with a beam of 59ft. and a depth of 59ft., with a measurement of about 7800 gross tons. Her special features include a protective bow and scantlings of the owner's high elastic limit steel, the use of which material has given a considerable increase in the designed deadweight carrying capacity. The cargo handling arrangements are very complete and comprise twenty-four special electric winches of the owner's design, which serve twenty-eight derricks, one of which is designed for a 60-ton lift. Part of the hull is reserved for the carriage of refrigerated cargo. The supercharged airless ignition propelling machinery which has been installed by the builders was supplied by Burmeister and Wain, of Copenhagen, and its designed total output will be 8600 B.H.P. at 110 r.p.m. under supercharged conditions. A very complete equipment of electrical auxiliary machinery will be carried. The first Blue Funnel Line "Ajax" was launched in 1866 and was a steamer of 2279 gross tons, with 822 I.H.P. engines, giving her a speed of 10 knots. The second "Ajax" was launched in 1900. She had a measurement of 7039 gross tons and was equipped with steam machinery of 4200 I.H.P., which was designed to give her a speed of 12½ knots. The new ship marks the great progress made during the last thirty years in the design of cargo liners, and emphasises the additional economies which are made possible in the owner's trade by utilising the oil engine propelled ship.

The Retirement of Mr. T. E. Thirlaway.

IT is announced by Swan, Hunter and Wigham Richardson, Ltd., that Mr. T. E. Thirlaway, who succeeded Sir George Hunter as chairman of the company in March, 1928, is about to retire from the board of directors, and that he will cease to be chairman on December 31st. Mr. Thirlaway will be succeeded in office by Mr. J. Denham Christie, the present vice-chairman of the company. Mr. Thirlaway started his business career with Messrs. Monkhouse, Goddard and Co., chartered accountants, and joined the firm of C. S. Swan and Hunter in 1898. On the amalgamation of that company with Wigham Richardson and Co., Mr. Thirlaway became the chief accountant of the new company. Although his principal interest lay in the financial sides of the many companies of which he was a director, he did not neglect to keep in close touch with the more technical aspects of shipbuilding and marine engineering practice. He is a man of shrewd foresight, and it is largely through his very skilful handling of the financial side of the business that his firm enjoys such a strong position to-day. He was also a director of many of the associated companies of Swan, Hunter and Wigham Richardson, Ltd., including the Wallsend Slipway and Engineering Company, Ltd., and Barclay, Curle and Co., Ltd., of which he is the chairman. Mr. Thirlaway has always been interested in any steps for furthering the prosperity of the shipbuilding industry and is a director of National Shipbuilders' Security, Ltd., which was formed to deal with redundant shipyard capacities in Great Britain. It is of interest to mention that Sir George Hunter, the late chairman of the company, was eighty-five years of age on Friday last.

The Fulham Power Station.

THE public inquiry by the Electricity Commissioners into the application of the Fulham Borough Council for consent to extend its generating station at Townmead-road, Fulham, ended on Saturday, December 20th. Mr. Trevor Watson, K.C., put in, on behalf of the London County Council, a written statement of the conditions which the Council thought should be imposed if the Commissioners granted the application. The conditions were that the sulphur content of the effluent gases should not be more than 0·02 of a grain per cubic foot; that no dark or opaque smoke should be emitted, nor grit or other particles sufficient to cause a nuisance. The chimneys, the statement went on to explain, should be at least 300ft. high, the gases should be warmed before discharge, the powers given to the Port of London in respect of water effluents should be extended to the London County Council, periodic analyses of gas and water effluents should be made, and any improved devices discovered should be introduced when the Electricity Commissioners required them. Mr. J. A. Robertson, consulting engineer, said that he had been engaged for thirty years in the construction of generating stations. A small number of stations spread over a large city did not cause so much damage through sulphur dioxide as one big station. He saw no insuperable difficulties in the way of a down-river station. The London Power Company's experiments at Grove-road were very promising, although the plant was elaborate and somewhat costly. He believed that the solution of the problem of the elimination of sulphur fumes was nearer than many people thought. In his final speech, Mr. Tyldesley Jones said that there was no alternative site that could be considered as a practicable proposition. Wherever the station was put the sulphur nuisance had to be prevented. Sir Frank Baines had proved conclusively that the distance at which a large amount of damage might be done by the presence of sulphur was far greater than the man in the street thought probable. He had given cases which proved that if all the generating stations for the supply of London were at Erith, London would still not be safe.

A Problem in Economics.

IN a White Paper issued on Thursday, December 18th, the Government summarised the principal measures which it has taken since it came into office for the relief of unemployment. The document shows that the total value of the relief schemes guaranteed, assisted or approved by the Government is £135,929,248. The basis of calculation adopted in the White Paper is that £1,000,000 provides work for one year for 4000 men. The schemes approved will therefore, it is claimed, provide work to the extent of more than 500,000 man years, or over 150,000,000 days of work. The Government has been in office for about eighteen months. Its schemes may therefore be said to have provided roughly 100,000,000 days of work per year at a cost of £91,000,000 per year. Our average unemployed number is about 2,000,000. To give all in that number employment for one year would require the provision of 600,000,000 days of work, and at the same rate as that applicable to the Government schemes would involve an expenditure of £546,000,000. It may therefore be said that the Government's efforts have resulted in the country's unemployed being one-seventh less in volume than it otherwise would have been. That is a figure of which the Government may or may not feel proud, but that its methods of relieving unemployment are economically unsound can readily be shown. The four railway groups have a combined issued capital of £1,124,960,758 and give employment to a total of 613,166 people. These figures imply that a capital expenditure of £1834 gives *perpetual* employment to one railwayman. The Government expends £250 to give one man a year's work. At that rate £1834 would give a man employment, not perpetually, but for 7¼ years. The comparison is not strictly correct. The economic value of the Government's schemes is not the immediate number of work-years provided by their execution, but the permanent volume of employment which they will create after they have been carried out. We have no idea and no means of forming an idea of how much perpetual employment the execution of the large variety of works included in the Government's approved schemes will bring into existence.

A Ropeway Plant at a Large Oil Works.

SOME time ago, the Agwi Petroleum Corporation, Ltd., of Fawley, Hants, was faced with the problem of devising some means to reduce the heavy cost of conveying drums and barrels of asphalt from its filling station and loading them into steamers for shipment. The original method was to convey the barrels and drums on platform trolleys, running along Decauville tracks, to a jetty out in the sea, and also to a wharf alongside the sea shore, where they were loaded into barges for conveyance to Southampton, to be eventually transferred into steamers. It will be easily understood that the handling charges with that system were very heavy.

After considering several alternate systems of conveyance, the Corporation decided to install a series of ropeways on the bi-cable system, and the order for these ropeways was entrusted to Messrs. R. White and Sons, of Widnes, Lancs. It was decided, after collaboration with the superintendent and the chief engineer at Fawley Works, to make the ropeway scheme in three units, which could be worked either separately, when required, or all three units at the same time. A reinforced concrete jetty was erected out in the sea in deep water, where ocean-going steamers could lie alongside for loading and unloading, and this jetty was connected with the shore and the works by means of a reinforced concrete gantry.

The plan, Fig. 1, shows the three separate sections of ropeways referred to. The first section from L T L to J L is called the "Land Ropeway," and it conveys barrels and drums from the filling station to the asphalt dump or storage ground. The second section from J L to L T S is called the "Connecting Ropeway," as it forms a link between the Land Ropeway and the third section, or the "Sea Ropeway," which extends from L T S right out to the jetty at point R T S.

The asphalt barrels or drums are conveyed in the first case from the filling station to the loading terminus of the Land Ropeway at L T L by means of two slat conveyors, each about 280ft. long, which pass through a tunnel underneath the main road before arriving at the ropeway loading station. At that point the barrels and drums are transferred to the ropeway, which conveys them to the asphalt dump, where they are stored ready for being conveyed directly out to the steamers lying alongside the jetty by means of the Sea Ropeway, as and when required. There are also arrangements for taking the barrels and drums direct from the loading terminus of the Land Ropeway at L T L, *viâ* the Connection Ropeway between J L and L T S, and thence along the Sea Ropeway direct to the jetty. In that case, of course, the three ropeway units will be working simultaneously.

On arrival at the jetty the barrels and drums are transferred from the ropeway carriers on to special sea loaders, by which they are lowered directly into the hold of steamers lying alongside, one Sea Loader being provided on either side of the jetty. By the same machines bundles of staves and the like can be unloaded from steamers by reversing the direction of their operation, so as to raise such materials up to the ropeway return terminus on the jetty for loading into the ropeway carriers, in order to take them on the return side of the ropeway back to the loading station of the Land Ropeway at the works, or to any intermediate point as may be required on the return journey.

Fig. 2 shows general profiles of the Land Ropeway and Sea Ropeway, whilst Fig. 3 gives a plan of the asphalt dump, which is about 280ft. long by 325ft. wide, and is capable of storing, say, up to about 20,000 tons of barrels and drums, stacked on end in five tiers. Fig. 3 also shows a profile of the Connection Ropeway between J L and L T S, as well as a section of another slat conveyor at the bottom of the asphalt dump. This conveyor first of all takes drums and barrels from the dump to point Q, at the loading station of the Sea Ropeway, where they are transferred to the ropeway carriers for sending out to the jetty. The same conveyor also carries barrels and drums from the dump in the reverse direction up to point R, where they are deposited on to a special loading platform, ready for loading into railway wagons when required.

The conveyor referred to as operating between points R and Q, and as indicated in Fig. 3, is made in two sections with a connecting joint at point P, one section from P to R being 210ft. long and the other section from P to Q 242ft. long. The two sections are driven through gearing by an electric motor, which is situated at point Q, and the construction of the conveyor is exactly similar to that of the two conveyors already referred to as running from the filling station to the loading terminus of the Land Ropeway. These two conveyors are also driven through gearing by an electric motor.

The whole ropeway system is designed for a capacity of 320 barrels or drums—or, say, about 68 tons—per hour, with two or three barrels conveyed on each ropeway carrier. The barrels and drums vary from about 30in. long by 18in. diameter to about 36in. long by 34in. diameter and weigh about 300–600 lb. each, respectively.

The Land Ropeway is about 4440ft. long measured all round, whilst the Sea Ropeway is about 6720ft. long measured out and home, and the Connection Ropeway, which forms a link between the two, comprises about 325ft. of double line ropeway, or, say, a total of 650ft. measured out and back again.

The three ropeway sections are made with intermediate steel standards, which vary from about 18ft. to 30ft. high and all of which are fitted with carrying rope saddles of the rocking type, and as will be seen

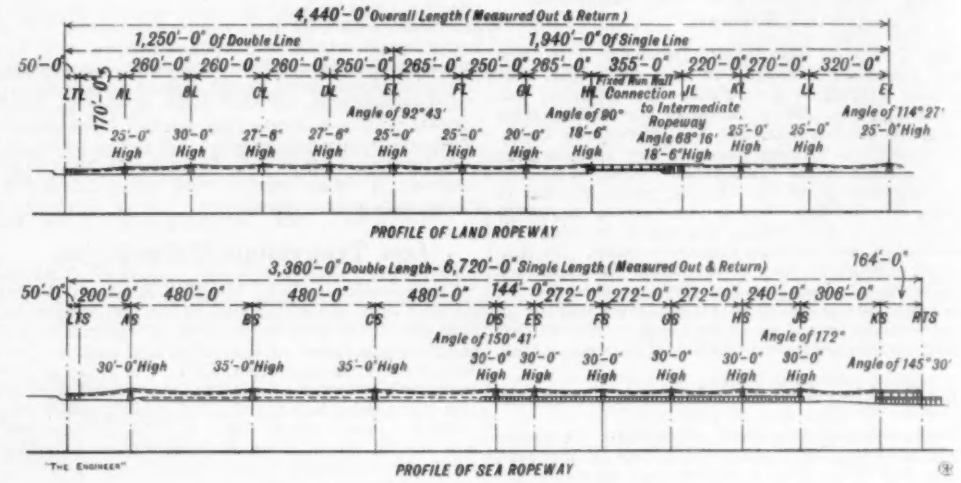

4,440'-0" Overall Length (Measured Out & Return)
1,250'-0" Of Double Line
1,940'-0" Of Single Line
PROFILE OF LAND ROPEWAY
3,360'-0" Double Length- 6,720'-0" Single Length (Measured Out & Return)
PROFILE OF SEA ROPEWAY
"THE ENGINEER"

FIG. 2—PROFILES OF LAND AND SEA ROPEWAYS

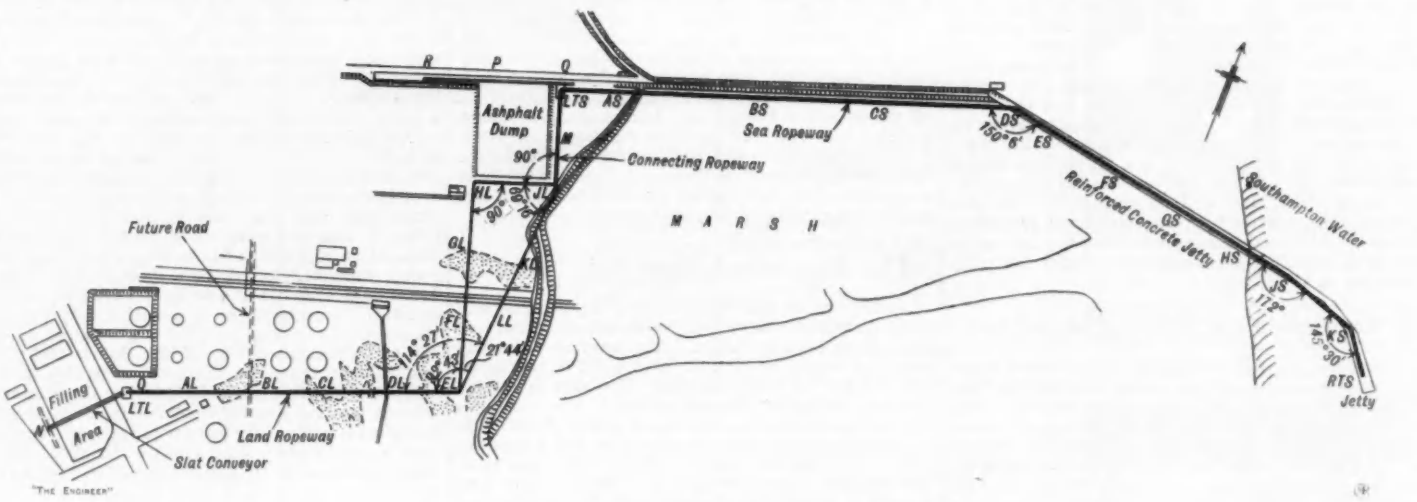


FIG. 1—PLAN SHOWING THE THREE SECTIONS OF ROPEWAY

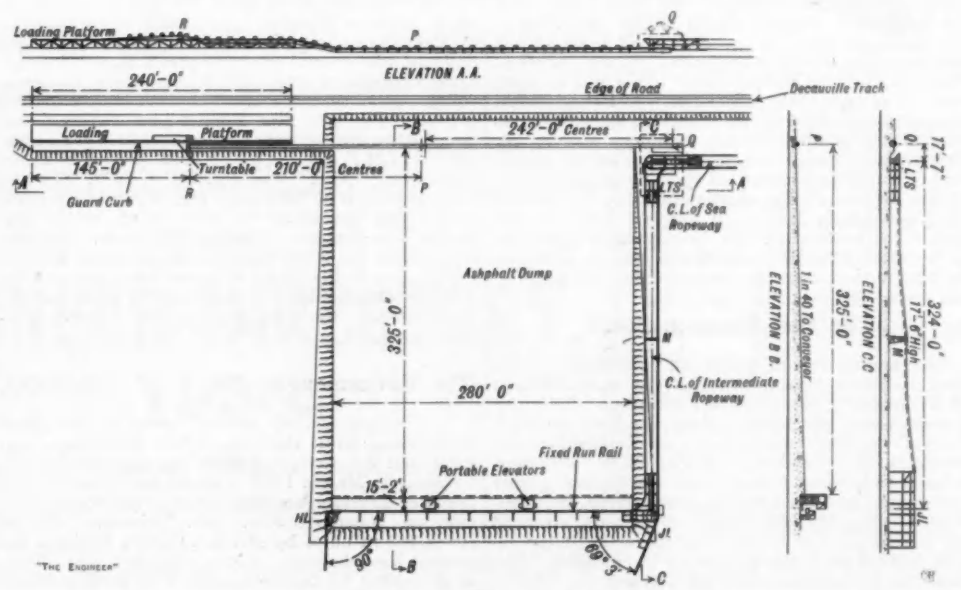


FIG. 3—PLAN OF ASPHALT DUMP

from Fig. 1, the Land Ropeway is constructed with three automatic angle stations at points E L, H L, and J L respectively, whilst the Sea Ropeway is made with three angle stations at points D S, J S, and K S respectively. Each of these angle stations is negotiated absolutely automatically by means of White's patented hauling rope gripper, and the carriers are conveyed through the whole of these angle stations, as also round the return terminus of the Sea Ropeway at point R T S, without disconnecting from the hauling rope, stopping, or handling in any way.

With a view to reducing the general attention and handling charges to a minimum, the contractors designed and patented a special carrier cage with a hinged adjustable bottom floor which can be tilted so as to form a slight incline in either direction, looking at the end view of the carrier, for the purpose of easy loading and unloading.

The barrels or drums when automatically leaving the slat conveyor, both at the loading station for the Land Ropeway, as also at the loading station for the Sea Ropeway, are deposited on to a loading platform set at a slight incline, so as to cause them to roll by gravity up to the edge of the loading bank, directly on to the inclined bottom floor of a carrier cage, standing in the right position for loading. Fig. 4 shows the end of the two slat Conveyors, which bring drums from the filling station to the Land Ropeway loading Terminus, and this view clearly indicates the tunnel underneath the road already mentioned above. Fig. 5 is a similar view, showing barrels ready for rolling on to the carrier cage floor from the loading platform. Fig. 6 illustrates one of the carrier cages in the right position for loading, and two drums are shown on the loading bank ready for rolling by gravity directly on to the floor of the carrier cage. Fig. 7 shows a carrier and cage with two drums locked in position in the cage ready for sending out on the ropeway.

A special buffer gear has been provided for stopping the empty carriers on the loading rail in the exact positions required for rolling barrels on to the cage bottom by gravity. As soon as a carrier cage has been loaded, the buffer gear is released by the man in charge pulling a lever, and the carrier is allowed to run by gravity along the inclined loading rail, to the front of the terminus on the outgoing side, where it is automatically attached to the hauling rope, and sent out on its forward journey.

Fig. 8 gives a good view of the stocking ground or asphalt dump, as also the first section of the Sea Ropeway down to the jetty.

Fig. 9 is a near view of the automatic angle station H L, together with the fixed discharge rail between H L and J L. This also illustrates a loaded carrier and box after passing the automatic angle station on its journey up to the discharging point.

Here it should be mentioned that it is necessary automatically to disconnect the loaded carrier and cage for discharging at any point between H L and J L for a distance of about 280ft. along the fixed discharge rail, between H L and J L—Figs. 1 and 3—and in order to provide a first-class working arrangement, involving as little attention as possible, Messrs. White designed a special portable unloading ramp, which is fixed directly to a portable barrel stacker, running on rails along the top of the asphalt dump, this machine being fixed in the housing shown in the illustration just referred to.

The barrel stacker with the unloading ramp attached is made to run the full length of the fixed discharge rail between H L and J L, and when a loaded carrier arrives opposite the stacker, it is automatically released from the hauling rope and stopped on the unloading ramp by means of a special buffer gear in the right position for unloading. The floor of the carrier cage is then tilted to allow the drums to run out by gravity for transferring directly to the stacking machine, which deposits them at any required height for stacking purposes. The asphalt dump is made with a slight incline from the discharge rail H L, J L, right down to the bottom of the stocking ground, so that barrels and drums, after being deposited on to any tier, can easily be rolled by gravity to any point for stacking.

Two of these portable elevators or barrel-stacking machines are provided for working on the rail track between H L and J L, and each of them is equipped with the special unloading ramp, as referred to above. After the carrier cage has been unloaded opposite any of the stackers in the manner described above, the man in charge has then merely to release the buffer gear to allow the empty carrier cage to run by gravity along the inclined gradient in the ramp, up to an automatic engaging gear, where the carrier is automatically attached to the hauling rope and conveyed round the angle station J L, also automatically, on its return journey to the loading station at L T L without any further attention.

Fig. 10 shows the storage platform for loading barrels and drums directly into railway wagons, as also indicated in Fig. 3, and, in addition, illustrates part of the section of the slat conveyor between P and R, with a barrel in the act of being conveyed

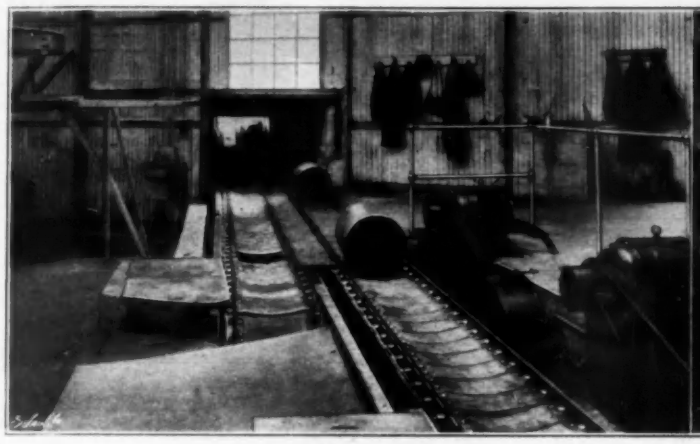


FIG. 4—ENDS OF TWO SLAT CONVEYORS

FIG. 5—BARRELS READY FOR LOADING INTO CARRIER CAGE

FIG. 6—CARRIER CAGE IN POSITION FOR LOADING

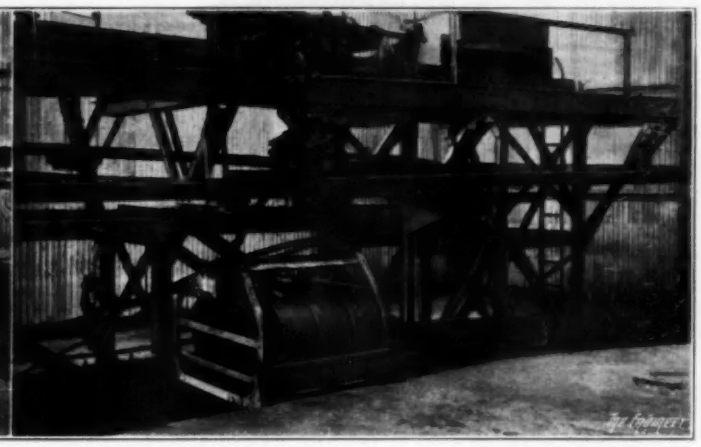


FIG. 7—CARRIER CAGE WITH TWO DRUMS LOCKED IN POSITION

FIG. 8—GENERAL VIEW OF BARREL-STOCKING YARD OR ASPHALT DUMP

up to the top of the storage platform. Fig. 11 indicates a back view of the portable barrel stacker, with its unloading ramp, and also shows a drum in the act of rolling by gravity from the cage on to the elevator platform. Fig. 12 is a front view of the same machine, with one drum just delivered on to the dump, whilst another drum can be seen in the elevator ready for depositing on to the barrel tier.

Fig. 16, page 708, is a view of the ropeway taken from the jetty, clearly showing the angle station J *s* in the foreground.

Fig. 17 is a near view showing general particulars of the automatic angle station D S.

Fig. 18 is a view showing the first section of the Sea Ropeway, and also indicating the Connecting Ropeway between the Sea Ropeway loading station and angle station J L of the Land Ropeway, while Fig. 19 gives a good view of the Sea Ropeway looking towards the jetty. As will be observed, the angle stations and standards fixed directly on the top of the ferro-concrete gantry, leading to the jetty, have all been made of special portal construction, in order to allow traffic to pass along the jetty without fouling the framework of the ropeway towers.

Fig. 13, herewith, shows the front of the jetty terminus with a loaded carrier approaching the automatic angle station H S. This view also indicates a steamer lying along the outer side of the jetty in position for loading from the special Sea Loader, and one of the canvas belt-type Sea Loaders can be seen in the act of depositing drums into the steamer's hold.

Fig. 14 shows a steamer lying on the lee-way, or inner, side of the jetty, together with the Sea Loader, in the act of discharging empty drums from the steamer for loading into the ropeway cages in order to convey these empty drums by means of the ropeway to the works, exactly in the same manner as described for conveying bundles of staves from steamers to the works. The other Sea Loader can be seen on the left-hand side of this illustration, which also shows a carrier cage loaded with empty drums on its return journey to the works.

It may be mentioned that the terminus on the jetty depicted in this engraving is about 170ft. long

FIG. 9—AUTOMATIC ANGLE STATION

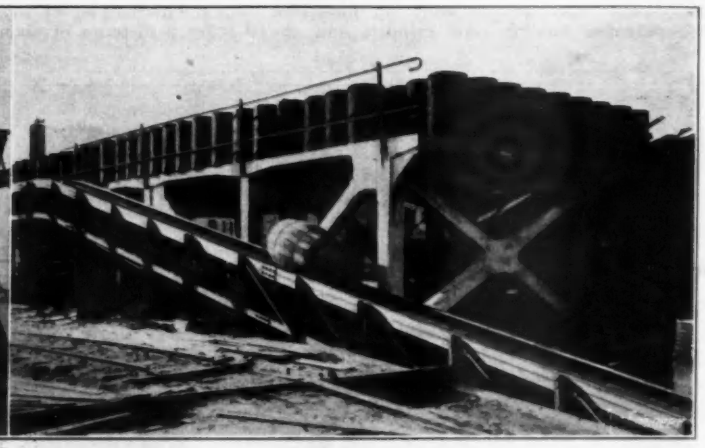


FIG. 10—PLATFORM FOR LOADING BARRELS INTO RAILWAY WAGONS

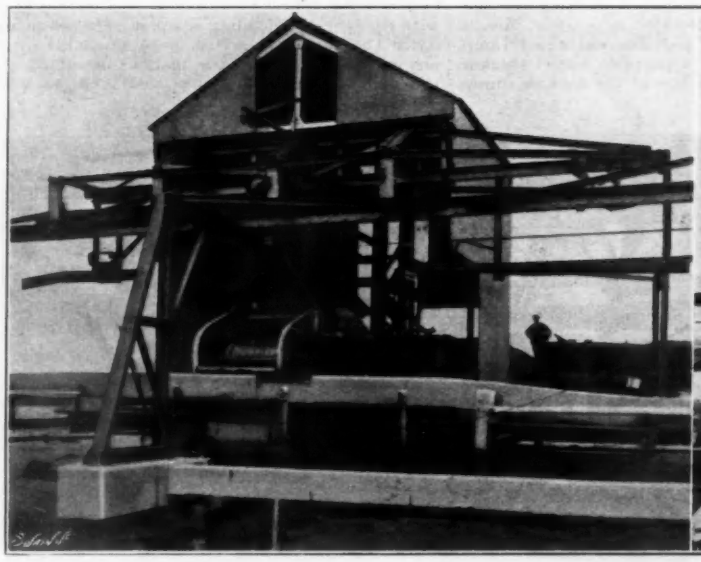


FIG. 11—BACK VIEW OF PORTABLE BARREL STACKER

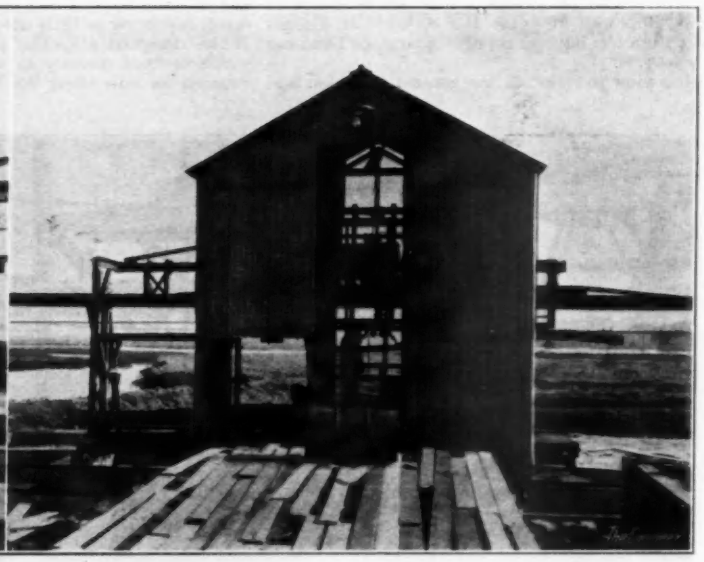
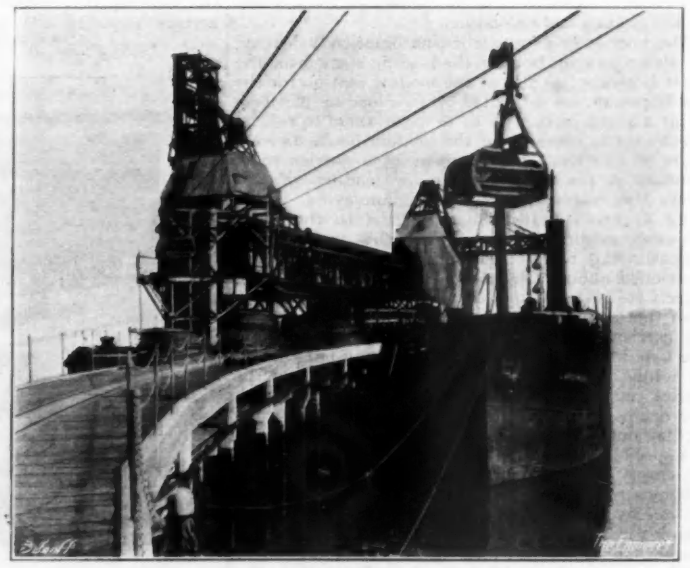


FIG. 12—FRONT VIEW OF PORTABLE BARREL STACKER



FIGS. 13 AND 14—VIEWS OF ROPEWAY ON JETTY

overall, with a fixed running rail on both sides.

The two sea loaders referred to as being one on each side of the jetty terminus, are both designed for running on rails along the full straight length of the jetty terminus, and to each of these sea loaders is attached one of White's patented unloading ramps, exactly similar to what has been previously described in connection with the barrel stacker working at the top of the dump.

The *modus operandi* in connection with the jetty terminus is briefly as follows.

When a loaded carrier cage arrives at either of the two sea loaders, it is automatically disconnected from the hauling rope at a fixed point on the unloading ramp, right opposite the canvas belt elevator and conveyor, in the same manner as already described in connection with the barrel unstacking machines at the asphalt dump. The cage floor is then tilted to allow the drums to roll out by gravity on to a platform leading them directly into the elevator slings, which raise the drums to the top of the horizontal conveyor beam, traverse them along that beam, and finally lower the drums vertically into the steamer's hold, where they are automatically delivered either on the bottom of the hold or on the top of any tier, as loading

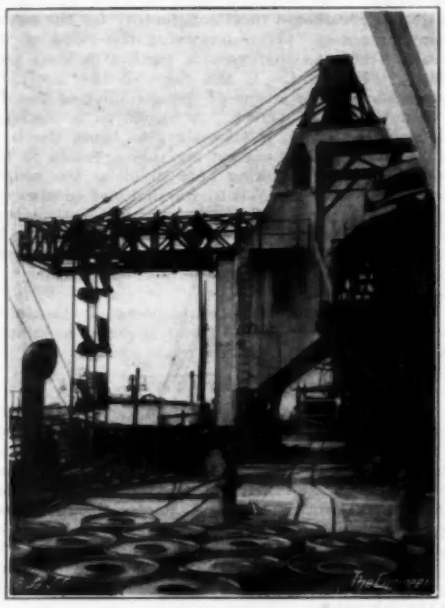


FIG. 15—ONE OF THE SEA LOADERS

proceeds. After discharging the drums the empty carrier cages are automatically connected to the hauling rope, and sent back to the loading station without any further attention whatever.

Each Sea Loader is equipped with a series of electric motors and driving gears to control the various operations of loading, &c., and also for moving these machines along the respective rail tracks on the jetty to any required point to suit steamers lying alongside. The position of the drum slings can be altered both vertically and horizontally for loading steamers of different sizes on varying tides.

Fig. 15 is a general view of one of the Sea Loaders and, as will be seen, the operating machinery is covered by a housing to protect it against weather. The operator of the machine is also stationed inside the housing shown. This engraving shows the manner in which the drums lie in the canvas slings of the elevator.

When these sea loaders are not in use, the horizontal conveyor beams or jibs, with their canvas slings, are pulled up in a vertical position, as indicated on the left-hand side of Fig. 14, referred to above, so as to be well out of the way.

Both the Land Ropeway and the Sea Ropeway are driven by electric motors of 25 B.H.P. each, with specially designed driving gears, while the Connecting Ropeway between the two main plants is worked from the drive of the Sea Ropeway.

The whole of this plant has now been working for a good while, and we understand that it has given entire satisfaction to the users, and that it has fulfilled all the difficult and arduous working conditions for which it was designed.

Cutting Pressures and Power Consumption of "Widia" Tools.

(By a Correspondent.)

IN the several technical communications that have been published in recent years on the use of, and experiences with, "Widia" or cemented tungsten carbide tools, one feature does not appear to have been sufficiently examined. It is the relative power consumption of such tools compared with high-speed steel tools.

It will be generally agreed that the most striking feature observed, when using these new tools for the first time, is the difference in character of the turnings produced; these do not appear to have suffered anything approaching the amount of distortion or punishment as do those produced at the same cut and feed with high-speed steel tools; they leave the tool in a different way with much less "curl"; the underside next the tool face is, in the case of steel turnings, much more polished and cleanly cut; the turnings are very much cooler; in short, the new tools appear to cut with more of an edge action and less of the "wedge and tear" action of the older tools.

The mechanism of failure in the author's experience

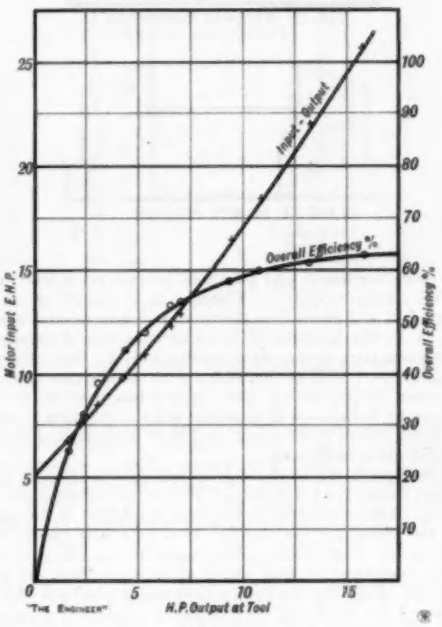


FIG. 1

of carbide tools is by dulling of the edge and not by the usual wearing forward of a cavity in the top face, as experienced with steel tools, lending further support to the above view.

Thus, there are grounds for expecting considerable reductions in the power consumption when cutting with the new material.

The author has found two sets of published measurements of power consumed, and in the following notes has compared them with the results of the investigation by the Cutting Tools Research Committee of the Institution of Mechanical Engineers[1] for high-speed steel tools and with Ripper and Burley's[2] figures.

The first set of measurements was given in abstracted form in THE ENGINEER of September 5th, 1930, page 247[3], from a paper by T. G. Digges, and are summarised and extended in Table I. These experiments were carried out on an 18in. centre lathe with geared head and driven by a 40 H.P. variable-speed motor, the whole arrangement being practically identical with that of the experimental lathe described by Ripper and Burley.[2]

TABLE I.

18in. centre lathe, 40 H.P., 220-volt variable-speed D.C. motor, cutting nickel steel with "Widia" tools; tool angles 14 deg. top rake, 6 deg. front clearance; steel S.A.E. 2330 in annealed condition.

Cutting speed, feet per min.	Feed, inches per rev'n.	Depth of cut, inches.	Area of cut, sq. in.	Cubic inches metal removed per minute.	Gross kW input to motor.	Gross H.P. per cubic inch removed per minute.	Net H.P. at tool.	Cutting pressure, lb.	Brinell hardness of material.	Cutting pressure (lb.) for Brinell of 202.
1	2	3	4	5	6	7	8	9	10	11
90	0·031	0·1875	0·0058	6·2	4·1	0·89	2·3	822	202	822
110	,,	,,	,,	7·7	5·4	0·90	2·6	780	202	780
120	,,	,,	,,	8·3	5·5	0·89	2·7	742	202	742
130	,,	,,	,,	9·0	6·2	0·92	3·5	887	230	776
140	,,	,,	,,	9·7	6·4	0·89	3·7	873	230	766
160	,,	,,	,,	11·1	6·8	0·82	4·1	847	230	742
90	0·096	,,	0·018	19·4	9·3	0·64	6·7	2460	168	2950
105	0·078	,,	0·0146	18·4	8·5	0·62	5·8	1870	168	2250
120	0·054	,,	0·010	14·5	7·1	0·66	4·4	1210	168	1450
160	0·031	,,	0·0058	11·1	5·5	0·66	2·7	558	168	670
200	0·031	0·125	0·0039	9·4	5·7	0·82	2·9	478	163	590
180	,,	0·1875	0·0058	12·5	7·2	0·77	4·5	826	180	928
160	,,	0·3125	0·0097	18·6	11·8	0·85	9·3	1920	180	2160
150	,,	0·4375	0·0136	24·5	16·6	0·90	13·5	2970	180	3330
140	,,	0·5625	0·0174	29·2	20·6	0·94	17·1	4040	180	4540

The efficiency curve for this lathe and motor has been plotted by the author in Fig. 1 from the efficiency test figures given in Appendix I. of the paper mentioned; this curve has been used to extend Table I., giving column 8 and thence column 9 of cutting pressures. To allow for the varying Brinell hardness of the materials used by Digges the figures of column 9 have been varied in ratio of the Brinell number to a common basis of 202 Brinell corresponding to 43 tons per square inch tensile strength, giving column 11; this follows the findings of Ripper and Burley[2] that work done per cubic inch—and therefore cutting pressure—is proportional to tensile strength. The results of column 11 have been plotted against area of cut in square inches in Fig. 2, in which is also included the result of Stanton and Hyde's experiments[1] for an almost identical steel containing 3·43 per cent. nickel, 0·36 per cent. carbon, Brinell 202 (*loc. cit.*, Fig. 31 for 70 deg. cutting angle), when cutting with steel tools. With the exception of three observations, taken with deep cuts, the results for "Widia" tools follow the character of Stanton and Hyde's results in that cutting pressure is proportional to area of cut, but the value is almost exactly half—160,000 lb. per square inch of cut, against 326,000.

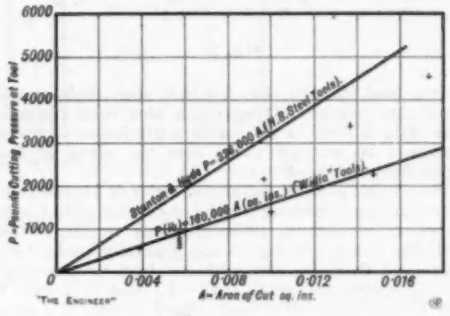

P = Pounds Cutting Pressure at Tool
Stanton & Hyde P = 326 000 A (H.S. Steel Tools)
P (lb.) = 160 000 A (sq. ins.) ("Widia" Tools)
A = Area of Cut sq. ins.
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FIG. 2

TABLE II.

18in. centre, motor-driven lathe cutting hard cast iron, 250 Brinell, with "Widia" tools.

Cutting speed, feet per minute.	Feed, inches per revolution.	Inches, depth of cut.	Area of cut, square inches.	Cubic inches metal removed per minute.	Gross kW input to motor.	Gross H.P. per cubic inch removed per minute.	Net H.P. at tool.	Cutting pressure at tool, lb.
1	2	3	4	5	6	7	8	9
630	0·059	0·08	0·0047	35·8	7·1	0·27	4·1	215
515	,,	0·16	0·0094	58·6	9·3	0·21	6·4	410
420	,,	0·24	0·014	71·6	12·1	0·23	9·2	724
354	,,	0·32	0·019	80·0	14·3	0·24	11·4	1060
302	,,	0·40	0·024	85·0	18·1	0·29	14·9	1630
256	,,	0·48	0·028	87·0	23·6	0·36	19·9	2560
			With H.S. steel tools.					
118	0·059	0·08	0·0047	6·7	4·4	0·88	1·4	392
89	,,	0·16	0·0094	10·0	5·5	0·74	2·5	930
79	,,	0·24	0·014	13·5	7·1	0·71	4·1	1710
72	,,	0·32	0·019	16·4	8·2	0·68	5·2	2390
69	,,	0·40	0·024	19·7	9·3	0·64	6·4	3060
66	,,	0·48	0·028	22·4	11·0	0·66	8·2	4100

Very similar results are obtained for turning cast iron; a series of observations of power consumption

[1] "Proc.," I. Mech. E., 1925, No. 2, pages 175 *et seq.*

[2] "Proc.," I. Mech. E., 1913.

[3] "Proc.," Am. Soc. Mech. E.

[1] "Proc.," A.S.M.E., March, 1929; MS. P. 51/10.

when turning that material with the new tools have been published by Prosser[1] in the "Proceedings" American Society of Mechanical Engineers. These are extracted in Table II. and are for cutting cast iron of 250 Brinell, corresponding approximately to a transverse strength of 31 cwt. on 1in. by 1in. test bar at 12in. centres, and a tensile strength of 14·5 tons per square inch; the lathe used was again similar in size to Ripper and Burley's, and the efficiency curves of Fig. 1 have been used to obtain the net H.P. at the tool and the cutting pressure, giving columns 8 and 9 of Table II. In the case of these experiments a duplicate set of readings for the same lathe cutting the same material with steel tools is given as extended in the second portion of Table II.

The results of columns 4 and 9 of Table II. have been plotted in Fig. 3, and the ratio of cutting pressure

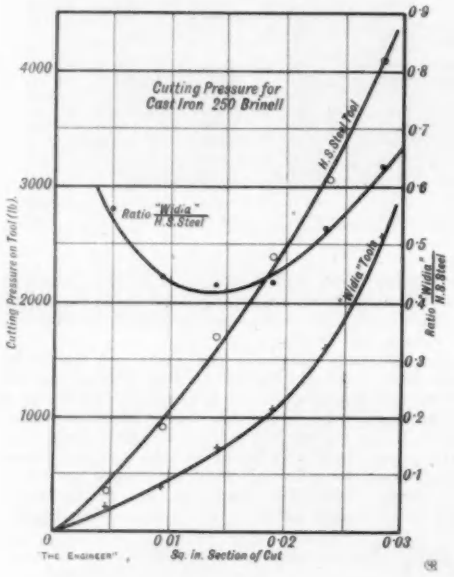

FIG. 3

for the new tools to that for H.S. steel tools at the same cut—depth and feed—has also been plotted. This ratio is seen to vary with a minimum value of 0·42 and an average value over the range of the experiments of about 0·5.

The results of both the above series of experiments show that, at increasing depths of cut, the power consumption of carbide tools increases rapidly; this probably has a bearing on the generally understood statement that the new tools are best used at high cutting speeds and small cuts. To each of Tables I. and II. columns have been added giving the gross H.P. consumed per cubic inch of metal removed per minute, as that is a commonly used method of determining lathe outputs and power requirements.

It is usual to use a figure of 1·0 when dealing with machining of mild steel up to 2·0 for hard steels—such as tires—and a figure of 0·5 when cutting a medium cast iron; these compare with an average figure of 0·8 in Table I. for a nickel steel, whilst Table II. gives 0·27 for the new tools cutting an iron considerably harder than what is usually considered medium grade. These results may be compared as an alternative with the statement in Ripper and Burley's paper (*loc. cit.*) for cubic inches of metal removed per net H.P. hour at the tool. Thus Table I. gives a value of 176, compared with 94 cubic inches for a steel of 43 tons per square inch derived from Ripper and Burley's equation. Similarly the figures for the two parts of Table II. are 380 for the new tools and 192 for H.S. steel tools when cutting cast iron of 250 Brinell.

Until more detailed experiments are available on the actual cutting pressures of carbide tools as measured by a tool dynamometer, it appears reasonable to take an approximate figure of half the pressure for the same cut when tungsten carbide tools in place of H.S. steel tools.

The Manufacture of S.A.A. Cartridge Cases.

By F. ADCOCK, M.Sc., Ph.D., A.M.I. Mech. E., Chartered Mechanical Engineer.

No. II. (*Conclusion*).*

CUPPING.

THE only method of cupping which will be considered here is the British system; that is, by using combination dies with concentric punches and feeding the machine with soft strip. The characteristic properties of the different positions in a multiple punch machine do not exist after the blanking operation has been completed, but a corresponding trouble is encountered in cupping. This is the difficulty of making a number of dies all alike. The base thickness of a cup is less than the thickness of the strip from which it has been made by from 0·002in. to 0·005in., depending on the contour of the die and variations in base thickness amounting to 0·001in. can be produced by dies, the differences between which can only be detected by specially careful inspection.

METHOD OF MAKING CUPPING DIES.

The dies are made by the following process:—A piece of steel is cut from a bar and turned on the outside, being held in a chuck. The hole is then drilled, bored, and reamered with a formed reamer. The die

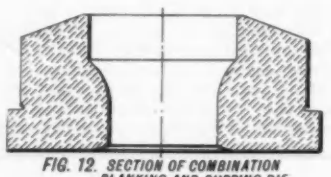

FIG. 12. SECTION OF COMBINATION BLANKING AND CUPPING DIE

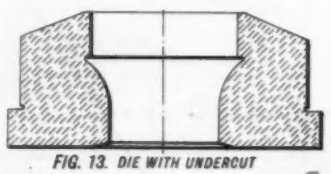

FIG. 13. DIE WITH UNDERCUT

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is then hardened and the hole lapped on a lead lap with emery powder. Finally, it is mounted on a mandrel and ground on the outside diameter and base. It is in the process of lapping that the differences between dies arise, and, unfortunately, this process cannot very well be dispensed with, as the dies always distort in hardening and have consequently to be brought to finished dimensions after hardening. Also, a high polish is required, and that necessitates treatment after hardening.

A typical die contour is shown in Fig. 12. It has been found that the portion of the die responsible for most of the variation in the base thickness of the cups is the lower part of the blanking hole just before the shoulder commences. The natural tendency is for the diameter at this place to be less than at the mouth of the die, and when that occurs the base thickness of the resulting cups is high. The ideal shape of the blanking hole is, of course, parallel, and in order to get it the die is bored with a diverging taper to compensate for the bell-mouthing effect of the lapping.

An attempt was made to facilitate the lapping of the blanking hole parallel by boring a slight undercut as shown in Fig. 13 to lap into. This resulted in the production of a ring on the outside edge of the cup, which became detached from the cup in a lower portion of the die, where it remained until the next cup came through. It then embedded itself in the surface of the latter. This tendency to form rings was also found in dies without undercut if the curve of the shoulder intersected the blanking hole at too sharp an angle. A slight curve is therefore desirable between the blanking hole and the shoulder in order to prevent it. An arc of 0·03in. radius is sufficient for this purpose.

A very interesting point to notice in the appearance of a cup is the slope of the mouth. Fig. 14 shows three cups exhibiting three different slopes of the mouth together with the contours of the dies which produce them. In (*a*) the mouth of the cup is said to slope "outwards" and the shoulder of the die is said to be "easy," while in (*c*) the mouth of the cup is said to slope "inwards" and the shoulder of the die is said to be "hard." The hardness of the shoulder of the die also affects the base thickness of the cups, an easy shoulder producing less base stretch than a hard one.

DESIGN OF CUPPING DIES.

The most appropriate shape of shoulder to make any desired type of cup has to be determined by experiment. The method adopted is one of successive trial and error. The necessary strip thickness is obtained as a first approximation by adding 0·003in. to the specified mean base thickness of the cup. The necessary diameter of the blanking hole of the die to give the desired weight of cup is then estimated, not purely theoretically, but by comparison with previous experience. A die is then made and tried. The first thing to notice in the cup is the slope of the mouth. An outward slope of from 15 deg. to 30 deg. is considered most satisfactory for the subsequent processes. After observing the slope of the mouth, the base thickness is next examined and, finally, the weight. If the slope of the mouth is satisfactory, the contour of the shoulder of the die is assumed to be correct. A correction is made to the strip thickness, if necessary, to bring the base thickness of the cup correct and a correction to the diameter of the blanking hole to bring the weight correct. Another strip is then rolled and another die made. This process is repeated until satisfactory results are obtained. Needless to say, this has to be done with four sets of tools in order to get the appropriate punch dimensions to compensate for positional difference.

It has been assumed for purposes of the above treatment that the type of cup required is known, and that is the case with cups made for sale.

ACCURACY OF CUPPING.

A considerable export trade in cups exists and the specifications for them set the general standard of tolerances for internal use. Some foreign specifications are very stringent and require the greatest possible care being taken and rigid inspection at every stage in the process. In fact, it was the increasing stringency of foreign specifications which caused the investigations here described to be taken up. As a result, the responsibility for fixing tool and strip dimensions has been transferred from the works to the laboratory.

The following tables show the improvement in accuracy which has resulted from this decision, together with the improvement due to increased accuracy of strip rolling.

Base Thickness.

Cause.	Extreme range of variation.	
	Works.	Laboratory.
	Inch.	Inch.
Strip thickness	0·002	0·001
Strip hardness	0·0005	0·0005
Differences between dies	0·002	0·0005
Other and unknown causes	0·0005	0·0005
Total	0·005	0·0025

Weight.

Cause.	Extreme range of variation.	
	Works.	Laboratory.
	Grains.	Grains.
Strip thickness	2·9	1·45
Positional difference	1·7	0·2
Density of material	1·2	1·2
Differences between tools	0·6	0·4
Total	6·4	3·25

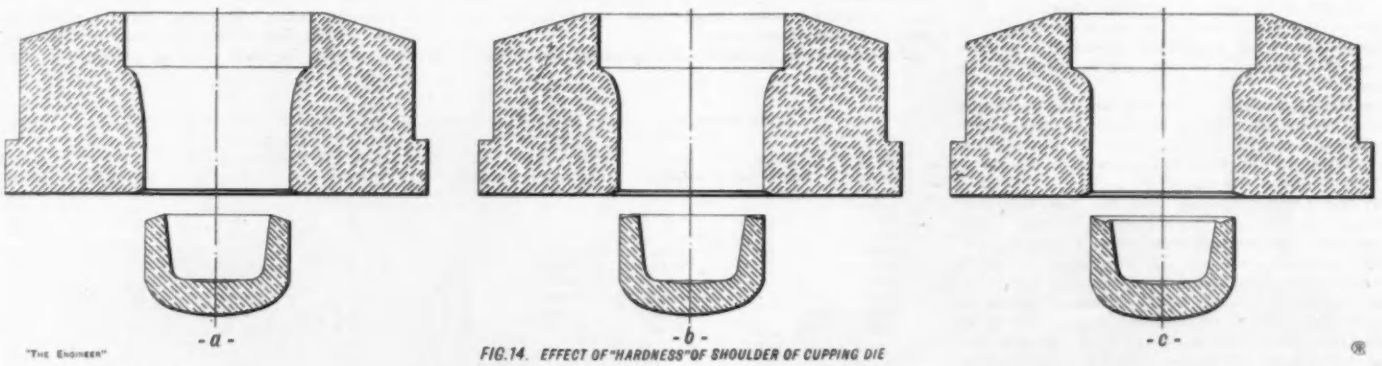

FIG. 14. EFFECT OF "HARDNESS" OF SHOULDER OF CUPPING DIE

* No. I. appeared December 19th.

PART III.—FROM THE CUP TO THE FINISHED CASE.

OPERATIONS.

The operations involved after cupping are of three different types, namely, drawing, indenting and heading and tapering. Each may be performed in more stages than one.

A set of intermediate products in the manufacture of the British Government 0·303in. Case by a typical scheme is shown in Fig. 15. From this it is seen that the operations involved consist chiefly of cupping, five draws, indenting, heading and tapering, and that the indenting operation is performed before the final draw. After the final draw, the product is cut off nearly to finished length, a small margin being allowed for subsequent mouth trimming.

ANNEALING.

After cupping and all draws except the last, the products are annealed in a muffle at 620 deg. Cent. for half an hour, quenched in 25 per cent. sulphuric acid and washed in warm water. After heading the products are mouth-annealed and similarly pickled.

LUBRICATION.

A 20 per cent. soap solution is used as a lubricant and coolant in cupping, drawing and tapering. Indenting and heading are performed dry.

DRAWING DIE.

A drawing die—Fig. 16—in general consists of three portions, known as the "top hole," the "shoulder" and the "back hole" respectively. The top hole is the parallel portion into which the product to be drawn fits and which keeps the undrawn portion of the product true with the drawn portion. This is about 0·002in. larger in diameter than the product which has to enter it. The shoulder is the tapered portion which does the drawing and the back hole is the minimum diameter which determines the diameter of the drawn product.

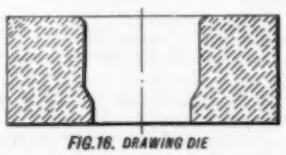

FIG. 16. DRAWING DIE

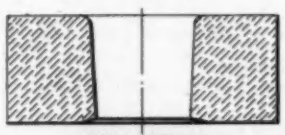

FIG. 17. BOTTOM DIE

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BOTTOM DIE.

As accuracy at each stage in the manufacture of cartridge cases is of the utmost importance, the working life of a die is short. In order to effect economy in cost of dies, the drawing die may be supplemented by a bottom die, the hole of which is a straight taper—Fig. 17. With this arrangement, the bulk of the reduction in diameter of the product is effected in the top die, while the bottom die has merely to "size" the product. The products are periodically tried in a two-hole plate gauge, the holes of which differ in diameter by 0·002in. for intermediate draws and by 0·001in. for the final draw. When the product becomes too large to pass through the "go" gauge, the bottom die is replaced. More wear is allowed on the top die and the life of a top die is determined largely by scratches developing on the product.

EXTRACTOR.

An extractor is a bottom die divided by radial cuts into three or more portions which are held together by springs. When a product comes down on the punch the jaws of the extractor spring apart and allow it to pass through. After it has passed through, the jaws of the extractor close on the punch and, on the return stroke, pull the product off. If no extractor is used the edge of the bottom die has to be kept sharp for the purpose of effecting the extraction. The grinding away of the edge increases the diameter of the back hole and so reduces the life of the die. The use of an extractor cannot, therefore, be too strongly urged.

EFFECT OF CONTOUR OF DRAWING DIE.

In general, the base of the product thickens successively at each draw. The amount of this thickening can be varied between certain limits by suitable choice of drawing die contours and also of cup diameter.

The effect of contour of drawing die on the base thickness of the product is similar to the corresponding effect already described in connection with cupping, a hard-shouldered top die producing less base thickening than an easy one and a bottom die with rapid taper less than one with slow taper.

EFFECT OF DIAMETER AND BASE THICKNESS OF CUP.

Increasing the cup diameter has the effect of increasing the base thickening which takes place in the subsequent drawing operations.

There is an economic advantage in using the thinnest possible strip, as the thinner the strip the less is the amount of scrap made at blanking.

INDENTING.

Indenting is performed on a horizontal machine. A set of indenting tools consists of a punch, a die, an indenting peg, and an extracting sleeve. These tools are arranged with the punch fixed and the die and peg moving, each being operated by its own crank. The sleeve slides between the die and the peg under the influence of a spring. The work is brought by a device like a pair of tongs into position in front of the punch. The die and peg then advance together and push the product on the punch. As soon as the product is safely started on the punch, the feeding device retreats to allow the die and peg to complete their forward stroke. On the return stroke they carry the product with them, and the latter is ejected from the die by the sleeve coming up against a stop before the die reaches its dead centre position.

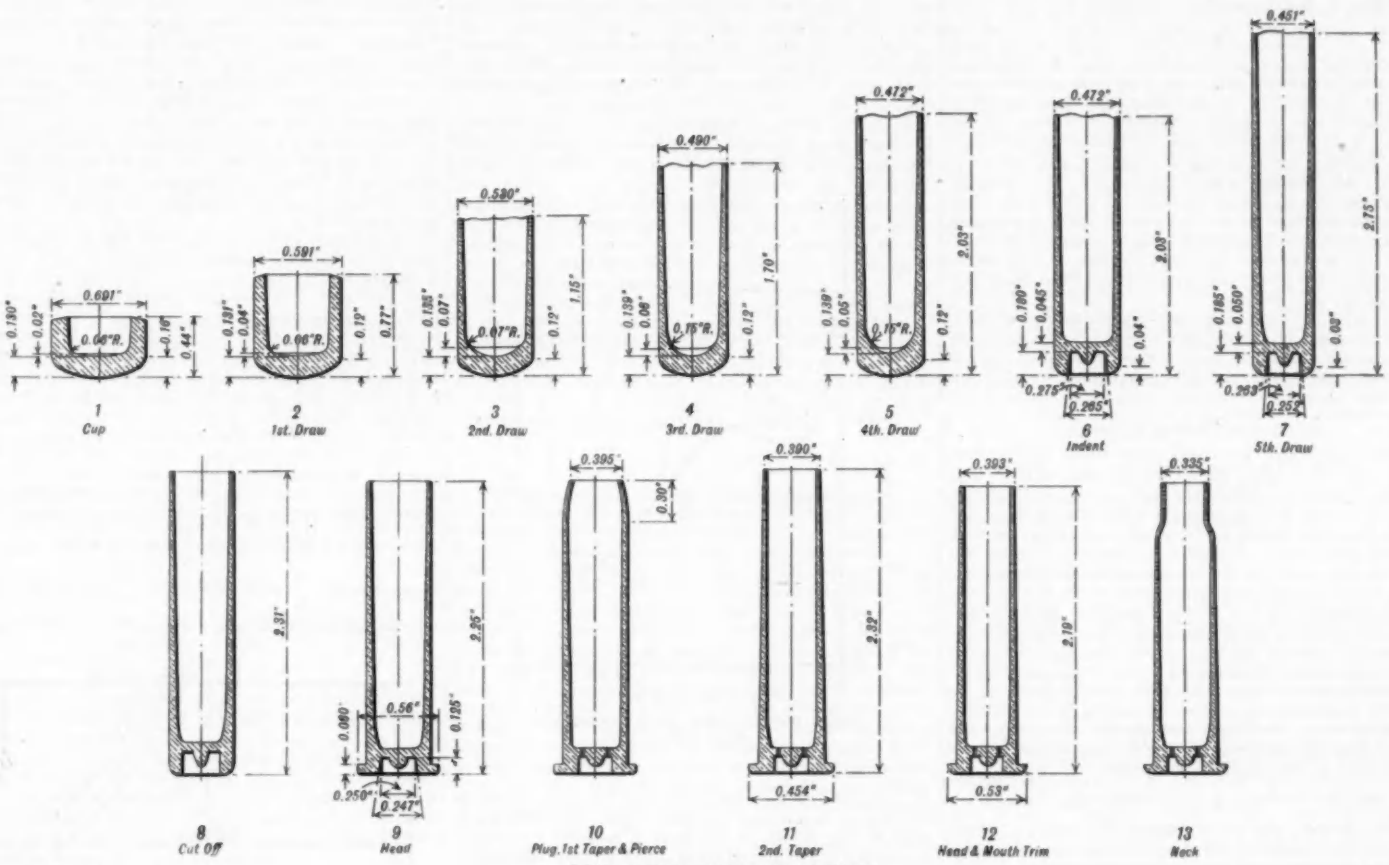


FIG. 15. INTERMEDIATE PRODUCTS, 0.303" CASE

Indenting presents more difficulty than is apparent at first sight. The metal displaced from the indent has to flow either into the head or into the wall. If a restriction is placed on the flow into the wall by a tightly fitting indenting punch, a fold develops at the internal radius between the base and the wall. Such a fold is shown in Fig. 18. In order to prevent this fold from forming there must be sufficient clearance between the indenting punch and the interior of the product to be indented, to allow the metal displaced from the indent to flow into the wall.

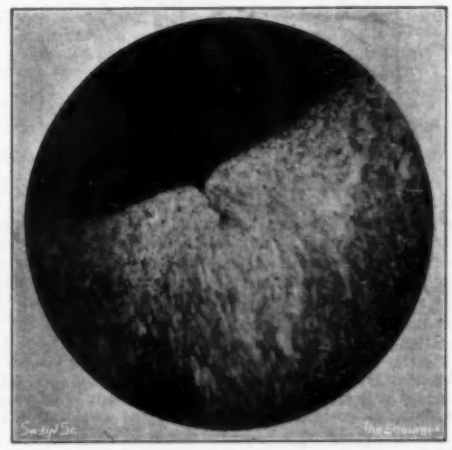


FIG. 18—SECTION OF CASE SHOWING FOLD (*Magnification 50 Diams.*)

From this it follows that in order to be able to indent a product without producing a fold there must be more metal in the base of the product before indenting than there need be if a fold is allowed to form.

HEADING.

Heading is done on a horizontal machine. The products to be headed drop into a groove behind the die into which they are pushed by the punch and held while the bumper advances, forms the head and recedes. The punch then withdraws, the head on the product causing the latter to remain behind in the die

and the cycle is repeated. As each product is fed into the die it pushes the previous product out in front of it.

No special difficulty occurs in heading the 0·303in. case, though in some other cartridge cases the bumpers break after a very short run.

The head of the case is marked with the maker's private mark and date of manufacture by characters imprinted on the bumper.

Mouth Annealing.

After heading, the cases are mouth annealed, pickled in dilute sulphuric acid, and washed first in water and then in soap suds before tapering.

Tapering.

Tapering is performed in two stages. Plugging, first-way tapering, and flash hole piercing are performed successively on one machine. The mouth of the case is first plugged to remove any irregularities which would cause the case to buckle in tapering, then tapered for a distance of about ½in. up, and, finally, the flash holes are punched in by small needle punches. Second-way tapering is performed on a separate machine of the horizontal type, somewhat similar to the indenting machine, except that the case goes in the other way round. The extraction is effected by a small peg which enters the case and pushes it out of the die.

The necking may be done at the same time as second-way tapering, but if the cases are to be loaded with cordite the loading is more conveniently done before necking, and in this case the necking is left till after loading.

Head and Mouth Trimming.

After tapering, the cases are head and mouth trimmed. The cases are placed by hand in a hopper, from which they fall automatically as required through a vertical tube into a magazine which turns them into a horizontal position in front of a rotating die with the mouths towards the die. A plunger advances and pushes the case into the die which causes it to rotate. The magazine and plunger recede while two turning tools advance, one in front of and the other behind the die, and trim the head and mouth simultaneously. A second plunger advances from the back of the die and pushes the trimmed case out ready for the recommencement of the cycle with another case.

The manufacture of the case may be considered finished with the head and mouth trimming, the remaining operations being merely assembling. These are capping, loading, and bulleting.

Design of Tools and Strip Thickness.

The logical way to develop the various operations in the manufacture of a cartridge case is to start at the finished case and work backwards. Unfortunately, it is not possible to obtain the intermediate products in this order.

In the general case it may be assumed that the specification of the finished case is given and that the various intermediate products have to be designed

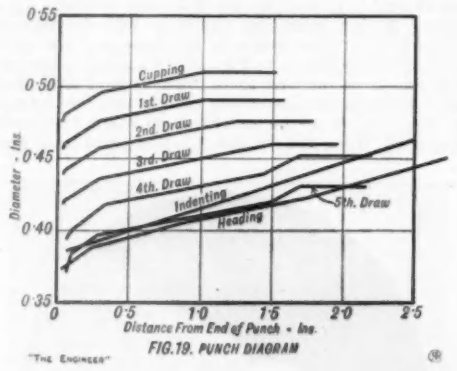


FIG. 19. PUNCH DIAGRAM

right back to the strip thickness. No universal rule can be given for this, but as a first trial the thickness of the strip may be taken as equal to the average thickness of the head of the finished case. The metal lost at indenting will be approximately balanced by the thickening of the base at the drawing operations.

After the strip thickness, the next thing to decide on is the blank diameter. This is chosen so that the weight of the blank is sufficient to provide an adequate margin over the specified weight of the finished case. For ordinary rifle ammunition, such as the British 0·303in., this margin may be taken as 25 grains.

The cupping and drawing punches are developed graphically by taking a longitudinal section of the interior of the case as it would appear before tapering, and building round it, allowing sufficient clearance between successive punches. The minimum clearance allowable is 0·005in. on the diameter. When an indenting punch has to be inserted between drawing operations, at least 0·020in. clearance should be allowed. It is convenient to draw this diagram of punches to a much larger scale diametrically than axially, as this accentuates the points at which the taper changes. Such a diagram is shown in Fig. 19, which shows a series of punches developed from the final draw punch in this manner.

Having developed the punches in this manner, the cupping and drawing dies can be determined by the reduction in area of the mouth of the product.

The maximum reduction in area at cupping recommended is 75 per cent. of the original area, the latter being taken as equal to the curved surface of a cylinder of diameter equal to the diameter of the blanking hole of the die and of thickness equal to the thickness of the strip.

In the final draw the annular area at the mouth of the product should be reduced by 33 per cent. and intermediate reductions should be chosen for the intermediate draws, preferably in the form of a descending sequence. A convenient method of securing this is to design the wall thicknesses of the successive products in geometrical progression.

A reduction in annular area of about 33 per cent. should be effected throughout the length of the product in the final draw in order to impart the requisite degree of hardness to the finished case.

A typical curve showing the distribution of Brinell hardness along the wall of the finished case is given in Fig. 20. The important place is just under the head.

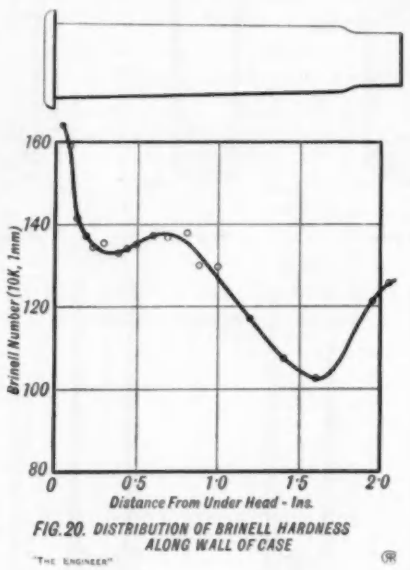


FIG. 20. DISTRIBUTION OF BRINELL HARDNESS ALONG WALL OF CASE

If the case is not hard enough here, it stretches when fired and makes extraction difficult. The hardness at the mouth of the case is reduced by mouth annealing after final draw in order to facilitate tapering and necking.

The final draw is the only one where the reduction along the wall has to be considered, as an anneal follows each of the other draws.

A trial is now made with the strip and tools calculated according to this system, and on the result of this trial the strip and tools for the second trial are deduced.

This process is repeated until a satisfactory strip thickness and set of tools are arrived at.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SAGS AND TENSIONS IN OVERHEAD WIRES.

SIR,—I welcome Mr. A. L. Galbraith's letter in your issue of November 21st last. I agree that the method described in the article "Sags and Tensions in Overhead Wires with Supports at Different Levels," in THE ENGINEER for June 13th, 1930, applies exactly only to the case of a vertical load. When wind is a factor, the transformation of length of span and difference in level of supports to Mr. Galbraith's L_2 and H_2 is, I think, a valuable improvement. On others of his points I differ.

If I follow Mr. Galbraith correctly, he assumes, in the last sentence of his second paragraph, that a cable, when acted upon by wind, will lie in a plane passing through the points of support and inclined to the vertical to such extent that the cosine of the angle between plane and vertical equals weight over resultant load. But does it? I have been privileged to see the hitherto unpublished results of the researches into this matter of F. W. Davey, B.Sc., A.M. Inst. C.E. They confirm my surmise that the cable in the case in question does not lie wholly in one plane. In fact, it lies on a warped surface. Accordingly, it would appear that the Galbraith transformation does not result in that exactness which we seek. It does, however, in cases where windage over weight is large and where $\frac{H}{L}$ is large too, add considerably to the accuracy of our calculated results. Therein lies its value.

In his tenth and thirteenth paragraphs Mr. Galbraith outlines an alternative method which he terms "probably the simplest." Here I differ from him, but that, maybe, is only a matter of opinion due to familiarity with another method. To mention one point: assuming that the cable when acted upon by wind does lie in one plane, then, to my mind, the procedure briefly should be this:—Evaluate H_1 and L_1 as Mr. Galbraith directs, and as tension and loading are known, the length of wire in span at that tension and loading may be determined. With that length as basis, find the load per unit length necessary to produce the given tension in span L_1 and difference of level H_1. Then proceed in the way I have described to determine tension with weight of cable only, or other vertical load, at any desired temperature. The tension being known, the sag naturally follows. I will take an example.

First, however, as Mr. Galbraith has mentioned, Martin's table of catenarian functions and for another reason which will appear, I would say that, in addition to Martin's table, I know of (1) that given in Thomas' paper descriptive of the chart known by his name; (2) a longer one in Painton's "Mechanical Design of Overhead Electrical Transmission Lines," suffering, so far as I have detected, from but one error and that an obvious one; and (3) a still longer table in Taylor's "Overhead Electric Power Transmission Engineering." The last is marred in my eyes by purporting to be of greater accuracy than actually it is. Because of that, and possibly because I had lost the copy of Martin's table which I had in Pittsburgh, I had a longer table calculated to five significant figures from 0·004 upwards as far as needful.

But the use of catenarian functions may be avoided, and the method I have described may be simplified by the use of hyperbolic functions only. That is to say, convert the span into part of a standard catenary, operate on that part by the use of hyperbolic functions, and convert the results of the operations into usual units. In that way I have constructed a tension length sag chart which enables tension and sag calculations to be made with ease and to give results which are sufficiently accurate for practical purposes. The chart connects tension at higher support in a wire of unit weight per unit length with length of wire in span minus straight line distance between points of support, the span length being taken as unity, and also with sag from lower support. The accompanying illustration shows part of the length curves on the chart. The curve O is for spans having $\frac{H}{L}=0$, the curve 0·5 is for spans having $\frac{H}{L}=0{\cdot}5$, and so on. Intermediate values may be interpolated by eye. Figures for constructing this

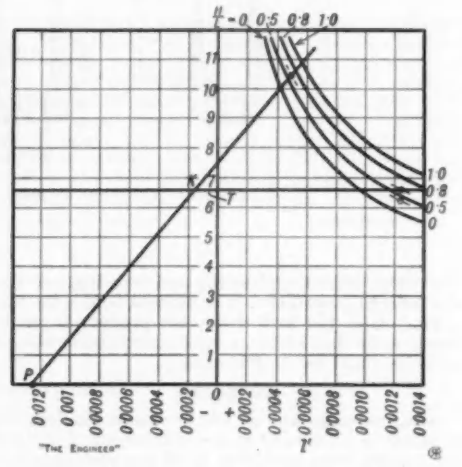


chart are given in "Sags and Tensions in Overhead Lines," soon to be published by Sir Isaac Pitman and Sons, Ltd.

Now for the example:

Cable = 30/0·132in. Al., 7/0·132in. St.
Diameter = 0·924in.
Cross-sectional area = 0·506 square inch.
Weight = 0·822 lb. per foot.
Modulus of elasticity = $11{\cdot}4\times10^6$ lb. per square inch.
Coefficient of linear expansion = $17{\cdot}8\times10^{-6}$ per 1 deg. Cent.
Maximum working tension = 12,300 lb.
Ice coat = 0·375in. radial thickness.
Wind pressure = 8 lb. per square foot.
Length of span = 1000ft.
Difference in level of supports = 600ft.

Those are the data. Evaluating the primary constants, we have:—

Weight of ice coat $= 1{\cdot}244\ (0{\cdot}375^2+0{\cdot}375\times0{\cdot}924)$ $=0{\cdot}606$ lb. per foot.

Weight of cable and ice $=0{\cdot}822+0{\cdot}606=1{\cdot}428$ lb. per foot.

Windage on ice coated cable $=\frac{8}{12}\ (0{\cdot}75+0{\cdot}924)$ $=1{\cdot}115$ lb. per foot.

Resultant load $=\sqrt{1{\cdot}428^2+1{\cdot}115^2}=1{\cdot}812$ lb. per foot.

The Galbraith transformation gives:—

$$H_2=600+\frac{1{\cdot}428}{1{\cdot}812}=473.$$

$$L_2=\sqrt{1000^2+600^2-473^2}=1065.$$

So that

$$\frac{H_2}{L_2}=\frac{473}{1065}=0{\cdot}44,$$

and

$$T_2=\frac{12{,}300}{1{\cdot}812\times1065}=6{\cdot}37.$$

From the chart, see illustration herewith, when $\frac{H_2}{L_2}$

$=0\cdot44$ and $T=6\cdot37$, $P_2=0\cdot00123$=excess length of wire in inclined plane at full load.

In vertical plane, when $P=0\cdot00123$, the chart shows that with $\frac{H}{L}=\frac{600}{1000}=0\cdot6$, $T=6\cdot60$. Therefore, equivalent

$$\text{load on wire}=\frac{12{,}300}{6\cdot60\times1000}=1\cdot863 \text{ lb. per foot.}$$

The elastic expansion in the wire at full load may be taken as $=\frac{12{,}300\times\sqrt{1+0\cdot6^2}}{11{\cdot}4\times10^6\times0\cdot506}=0\cdot00249=e_E$

The relative expansion with weight of wire as only load $=0\cdot00249\times\frac{0\cdot822}{1\cdot863}=0\cdot00110=e_w$

The unstressed length at basic temperature $=P-e_E$ $=0\cdot00123-0\cdot00249=-0\cdot00126=P$

$$P+e_w=-0\cdot00126+0\cdot00110=-0\cdot00016=k.$$

Whence, by drawing Pk line on chart, $T=10\cdot35$ and tension in wire at basic temperature and load that of weight of cable $=10\cdot35\times0\cdot822\times1000=8500$ lb. Whence tensions at other temperatures and sags may readily be obtained.

In his seventeenth paragraph Mr. Galbraith gives a formula for the calculation of the distance between the axis of the catenary and the centre of span. That formula involves much arithmetical work. Therefore I prefer to use my key chart, which enables similar results to be more quickly obtained.

And in his final paragraph Mr. Galbraith states that it is his practice to check the level of the centre point of span by theodolite. Is that necessary? Would not practical needs be served by measuring the incline sag by sight line, as is done in the measurement of sag when supports are at the same level? The incline sag is readily evaluated by use of this formula:

$$S_i=\frac{c\,H}{\text{Cosh }\gamma-\text{cosh V}}$$

wherein

S_i = incline sag = vertical distance between straight line joining points of support and the tangent to the wire parallel to that line.

H = difference in level of supports.

$c=\text{cosh }\gamma-\text{cosh }a-b.$

$\text{cosh }a=\text{sec }\theta$, θ being the angle of inclination of the straight line joining points of supports with the horizontal.

$b=(\gamma-a)\tan\theta$,

and V and γ the horizontal distances from the axis of the catenary to the lower and higher supports respectively on standard catenary.

To conclude, again I welcome Mr. Galbraith's letter. Would that others showed as great interest in this problem and contributed so well to its solution. Did they, we might reasonably expect soon to possess a method for an admittedly difficult case that would be mathematically precise, physically correct, and practically useful.

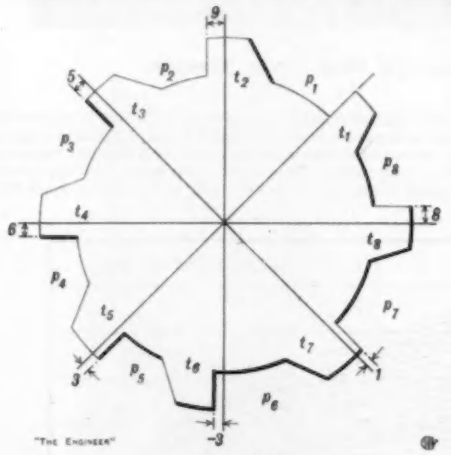
C. G. WATSON, M.I.E.E.

Welwyn Garden City, December 16th.

DIVIDING THE CIRCLE.

SIR,—I have to thank the four correspondents who in your current issue provide suggested solutions to the problem concerning the correction of the teeth of master dividing wheels, which I raised in my letter appearing in the issue of December 12th. I have also to thank you, Sir, for letting me see the replies received from four other correspondents.

Of all the replies, I like best Professor Bulleid's. It is so short that I may quote it in full: "Start from any tooth and calculate the necessary correction of the others for



reference to it, positive and negative. Then start again from the one with the largest negative correction, when it is evident that the correction of all the others will be positive." That answer is obviously correct, as will be seen from the enclosed sketch, in which I have laid down the uncorrected wheel which I mentioned by way of example against reference axes which are to be assumed as correct. Any tooth, actually tooth 1, is taken as zero, and is aligned with one of the reference axes. The others overlap or underlap their axes by the amounts shown. The greatest underlap—actually the only underlap in this setting—is that of tooth 6. Obviously, if we turn the wheel anticlockwise through 3 units, tooth 6 will register with its axis and all the others will overlap. Tooth 6 is clearly the one and only tooth which may be taken as the starting point of the correcting process.

This demonstration shows that if by accident the maximum underlap is shown by two or more teeth, either of these teeth may be taken as the starting point, and that whichever is taken will make no difference to the amount of metal to be removed from each of the other teeth. In general, there will, however, be only one tooth exhibiting the maximum underlap and therefore in general there will be only one tooth from which to start the correcting process. The demonstration also shows that having found the correct tooth, it makes no difference whether the correcting process is carried out clockwise or anticlockwise, and that the same tooth is the correct starting point for either direction. This fact will perhaps be particularly noted by your correspondent "Dalgian," who suggests that the correct starting tooth in my example is No. 6 for the anticlockwise direction and No. 2 for the clockwise. The same correspondent will no doubt also note from the diagram that the possibility of correcting the teeth by the removal of metal requires, in the anticlockwise direction, that the first pitch to be corrected should be greater than the mean, and in the clockwise direction that it should be less than the mean. The fact that the first pitch clockwise after tooth 6 is 245 permits that pitch to be corrected by the removal of metal from tooth 5. It does not, as he says it does, require the addition of metal.

The problem has been solved, but I wonder how many of your correspondents have appreciated the fact that in practice the correcting process cannot be carried out precisely in the manner indicated, namely, by removing calculated amounts of metal from each successive tooth. To return to my original example, the calculated amounts to be removed from the teeth are as follows:—

t_0	t_7	t_6	t_5	t_4	t_3	t_2	t_1
0	4	11	3	12	8	9	6

We cannot perform the correcting process with absolute accuracy. Let us suppose that we are able to work to an error not exceeding one-thousandth of an inch. The correcting process applied to each pitch successively will then result in all the pitches from p_6 anticlockwise to p_4 being $251\pm0\cdot001$. It is obvious, therefore, that the correcting process may leave the last pitch p_5 with a very considerable uncorrectable accumulated error, an error which may amount to as much as 0·007in. What is the best way of avoiding this accumulation of error? The best way of incurring it is to correct each pitch by removing the calculated amounts from the successive teeth. Clearly, we should first go round the wheel correcting every second tooth, using the intervening incorrect teeth as the zeros of reference for the removal of the calculated amounts. Thereafter we should correct the intervening teeth, not by removing the calculated amounts from them, but by splitting them between the two "corrected" teeth adjacent to them. We must then remeasure all the pitches, find out the new zero tooth and start correcting the wheel a second time. In this way only can the pitches be brought to within the required limits of accuracy, and the accumulated error eliminated.

London, December 20th. IXION.

SIR,—I regret that I partly misunderstood the problem set, and must apologise to "Ixion" for suggesting that he was wrong in one case.

In fixing the zero for the clockwise direction I had assumed that the teeth also faced in that direction.

In my method, the step-by-step summation of the numbers must always be positive when working round in the direction in which the teeth face, and negative when working in the opposite direction. This gives the sixth tooth as the starting point for both directions in the actual example chosen. When the teeth are set to face the opposite direction—clockwise—then with the same respective pitches the second tooth will be the zero for both directions. DALGIAN.

Woking, December 20th.

American Engineering News.

Railway Electrification.

FOR the electrification of the New York suburban system of the Delaware, Lackawanna and Western Railroad, multiple-unit trains with two-car units are to be used. Each unit will consist of one motor car and one non-motor or trailer car, and the units may be operated singly—as at periods of light traffic—or coupled into trains of four to twelve cars. The equipment includes 140 motor and 140 trailer cars to operate 70 miles of line, or 160 miles of track. They include six parlour cars and fifteen with mail and baggage compartments. All the cars are of steel construction throughout, except that the motor cars have aluminium doors, inside lining and roofing. They are about 70ft. long, seating eighty and eighty-four passengers each, the motor cars weighing 70 tons and the trailer cars 50 tons. The motors—four on each motor car—are of 240 H.P., 1500 volts, but insulated for a working potential of 3000 volts. With its gears and accessories the motor complete weighs about 7000 lb. Special equipment includes roller bearings on the axles and pantagraphs, electro-pneumatic brakes, motor ventilators with air inlets in the roof, and heater circuits of 3000 volts. For ventilation of the motors, air drawn in by roof fans at a velocity of 50ft. per minute passes to a large chamber fitted with baffles, where it loses its velocity and thus drops dirt, snow, or foreign matter. This arrangement avoids the use of filters. The air then passes to ducts leading under the floor and having flexible pipe connections to the motor casing. The motor pinion is of 2¼in. pitch diameter with twenty-two teeth. It gears with a fifty-nine-tooth spur wheel on the axle. For the brake system an air compressor with 1500-volt motor is slung under the car by a three-point suspension arrangement. The wheels are 38in. in diameter and may be run until worn to 35in. before reaching the clearance limits under the motors. The trains and motor equipment are designed for a maximum speed of 65 miles per hour on level lines.

Ventilation for Railway Cars.

Railway journeys in the summer, especially in certain sections of the country, are often uncomfortable on account of hot weather. Fans only slightly alleviate the conditions. At least some of the windows are open, and in spite of screens and deflectors, there is an unpleasant quantity of dust and soot. To improve these conditions some railways have equipped dining cars with special apparatus for cleaning and cooling the air. While this work is experimental, the cars are operated in regular service, and it is found that on a line crossing desert country where the atmospheric temperature is about 104 deg. Fah., the interior of the car can be kept easily at about 70 deg. Fah., although the cooking ranges are in full operation. In a test in which the interior temperature was allowed to reach 93 deg. Fah., the cooling apparatus reduced it to 70 deg. in about twenty minutes. The air is kept in circulation, without causing draughts. Fans draw air from the body of the car and from roof inlets and deliver it to filters which remove dust and other foreign matter. The clean air then passes over cooling coils and then through ducts along the sides of the ceiling, whence it passes into the car either through long slots concealed by baffles or diffusion plates or through openings fitted with louvres. These parts are concealed by or are included in the decorative features. Power is supplied by two motors driven from the axles, and by batteries when the car is at rest or moving at a speed of less than 15 miles an hour. The temperature is regulated by a simple switch and its regulation is controlled by the car steward. The cars have double windows, permanently closed, and the doors are automatically closed by pneumatic cylinders. As a rule the inside temperature is kept at 10 deg. to 15 deg. below the atmospheric temperature. One of these dining cars is 85ft. long, weighs 102 tons, and seats thirty-six persons at the tables.

Heat-resistant Cast Iron.

That a cast iron capable of resisting corrosion and heat effects can be produced at reasonable cost in any efficient foundry is a conclusion arrived at after extended studies and experiments by the American Nickel Company. The material is a nickel-chromium-copper cast iron, with an approximate analysis as follows:—Total carbon, 2·75 to 3·10 per cent.; nickel, 12 to 15; copper, 5 to 7; chromium, 1·50 to 4; manganese, 1 to 1·50; silicon, 1·25 to 2; sulphur, 0·04 to 0·12, and phosphorus, 0·04 to 0·30 per cent. Both laboratory and service tests indicate that such material has a life much greater than plain iron and almost comparable with bronze. Except for being much more resistant to heat and corrosion than plain iron, this alloy iron is, in general, similar to the former in its characteristics. It can be produced in an ordinary cupola and can be moulded, cast and handled in the foundry and machine shop in practically the same way as plain grey iron. It can be readily cast, machined and welded. It is non-magnetic and has a high electrical resistivity, or a conductivity of only 1·25 per cent. that of copper. But by special heat treatment or variation of the composition it may be made magnetic or non-magnetic without reducing its resistance to corrosion. For temperatures up to 1500 deg. Fah., it may be ten times more resistant to oxide formation than plain cast iron in an oxidising atmosphere. More important is its practical freedom from growth brought about by cycles of heating and cooling. This alloy iron has been used for valve seats, pump valves, pump liners, &c., oil refinery pipe systems handling corrosive liquids, and also at paper and sugar mills, for sea-water pumps and for experimental propellers. In the heat-resisting field it is being used for glass rolls, glass annealing furnaces, furnace parts and links of mechanical stokers, with a life six to ten times that of similar parts made of plain iron. For its electrical properties it is used in switchboard fittings and railway electrification and signal work.

Testing Welds.

Methods of testing welds by X-ray, gamma rays and magnetic measurements were presented in some variety at the annual meeting of the American Welding Society. Stress was laid on the diffraction or interference methods of using X-rays, which have been little used for such study, but which were said to be of greater value than the more usual radiographic methods. The former show the manner in which the atoms are grouped, which is of special value in the study of alloys. They also indicate the granular structure of the metal, upon which its physical properties largely depend, more especially those properties which are important in relation to welding. Much information obtained by such X-ray studies cannot be obtained in any other way. Another line of development is the use of "gamma" rays from radium emanation to examine heavy castings and large welds for the detection of internal defects. Instead of the X-ray apparatus, all that is needed is a small radium capsule which can be easily placed on a steel bridge or building and it can also be used under water. The bulb of emanation is supported in front of the weld, which has a photographic film in an envelope fastened to the opposite side. These rays are similar to those which would come from an X-ray tube operating at several million volts, instead of 100,000 to 200,000 volts, as in ordinary radiography. In a variation of the test by magnetic resistance or reluctance, a magnetic flux is passed through the welded seam, in the same way as for making magnetographs, but by measuring the magnetic-potential drop across the weld and for an equal distance in the solid metal, the test is more quantitative than the magnetographic method, and is more nearly free from the influence of personal judgment. So far this method has been used more in laboratory studies than in shop inspection, and it appears to be limited to the testing of butt welds.

Constant Current Electric Driving on the Austin System.

In our issue of November 10th, 1928, we described the Austin constant-current variable-voltage system, which is applicable to the driving of marine and other auxiliaries. Since the publication of the article the system has made considerable progress, and during a recent visit to the works of Gilbert Austin, Ltd., at Cathcart, Glasgow, we were afforded an opportunity of witnessing the performance of a demonstration equipment which has been erected at those works. For full technical particulars of this constant-current system we must refer our readers to the article to which we have alluded. Here it must suffice to say that the system has been developed in order to take advantage of the underlying principle of variable voltage by connecting motors in series, the objective being to provide a motor having the qualities of the steam engine, which takes little or no steam from the boiler when stalled, and so to overcome the fundamental defect of the ordinary electric motor, which takes an excess current in an endeavour to maintain the speed. To those unfamiliar with the system the statements that an overload on the motor produces an underload on the generator, and that when a motor is overloaded until it stalls the torque will rise some 50 per cent. or more and the load on the generator will fall to perhaps 10 per cent. or less, may appear a little odd, but these results are, nevertheless, obtained in practice.

The aggregate horse-power of these constant-current equipments now in use exceeds 10,000 horse-power, and there seems justification for the belief that the system has come to stay. The absence of fuses and circuit breakers is obviously an advantage, whilst the value of the current can now be corrected with such rapidity that the control levers of the motors may be handled with an abandon which is really surprising.

The system is now in use on a number of vessels, the latest to be equipped with it being the 25,000-ton motor ship "Lafayette," of the French Line. The 60-ton windlass has two motors, while five 20-ton capstans have motors of the same size. The type of motor used is illustrated in Figs. 1 and 2, the latter showing the cover removed and indicating the accessibility of the design. Each of these motors is capable of developing 190 brake horse-power at 700 revolutions per minute, but the speed range is from a creep up to 1080 revolutions per minute. On the windlasses they are geared for the utilisation of the full maximum horse-power, but on the capstans they are required to develop 80 brake horse-power at the very low speed of 180 revolutions per minute, so as to be able to speed up with pulls less than 20 tons until finally, when pulling in the light rope, they run at 1080 revolutions per minute. In practice, therefore, the machines do heavy pulling at speeds well below 180 revolutions per minute, and at these speeds the counter E.M.F. is small, with the result that the energy demand is correspondingly small—say, 40 volts at 250 ampères or 10 kW. The regenerative action in lowering loads is highly satisfactory; even the energy stored in the revolving armature is liberated for use in other motors, and as a result of these characteristics the energy demand of the seven motors when manœuvring a vessel is exceptionally low, the peak load being only about 80 kW, whereas with the usual equipment it would have been about 500 kW.

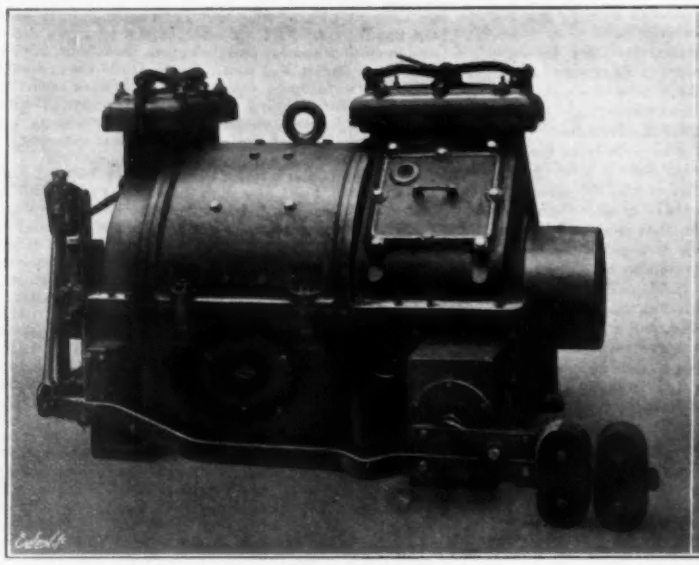


Fig. 1—Capstan Motor

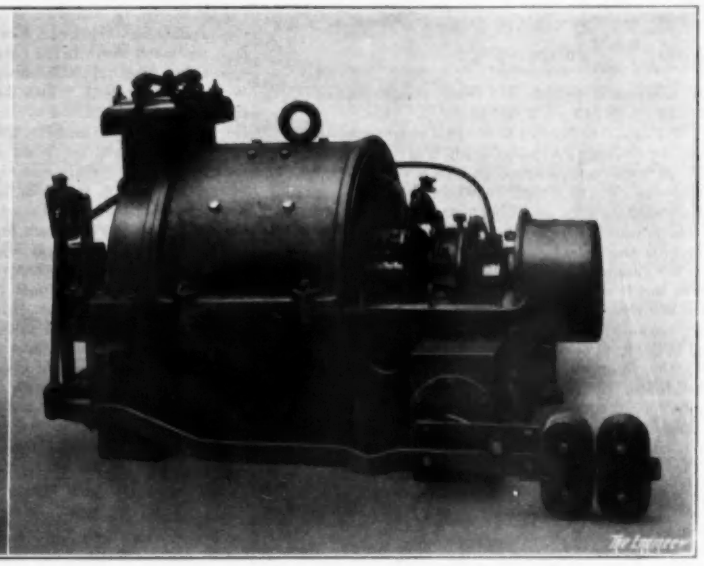


Fig. 2—Capstan Motor with Cover Removed

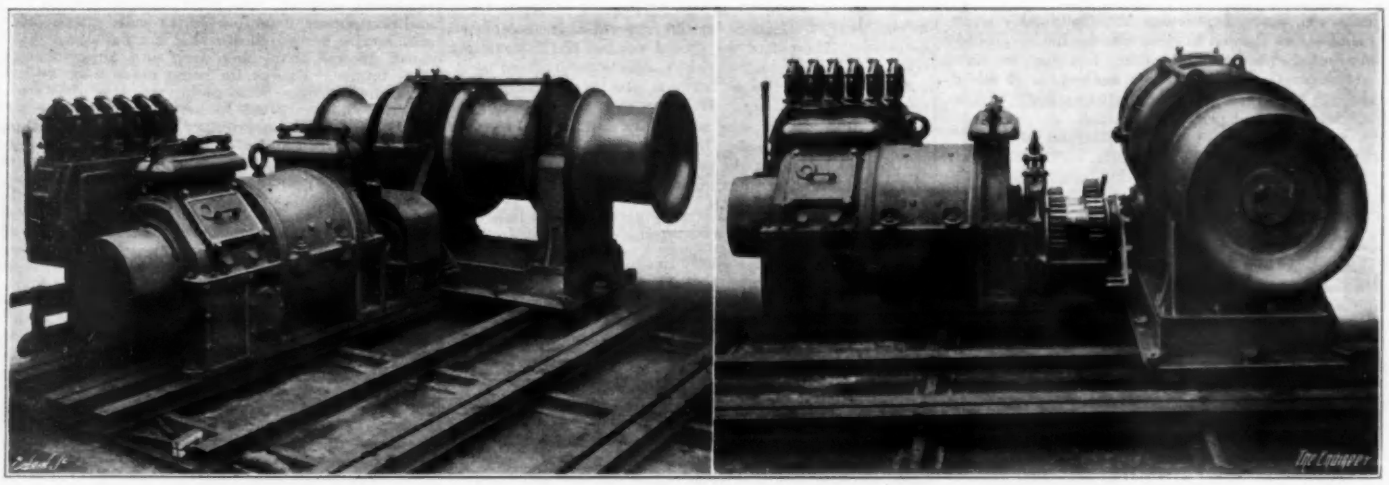


Fig. 3—Constant Current Winch

Fig. 4—Winch with Gear Cover Removed

The controller, which is shown in Figs. 7–9, is of a special type, designed to withstand the rigours of Atlantic weather on the exposed forecastle deck and with a ribbed radiating plate embedded in the stool supporting the apparatus. Usually these radiators are fitted on top of the controller,

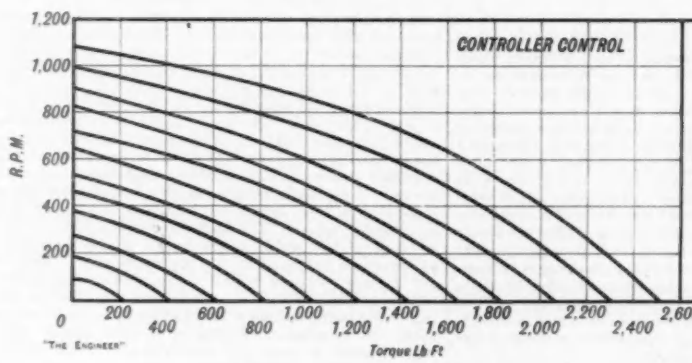


Fig. 5—Controller Curves

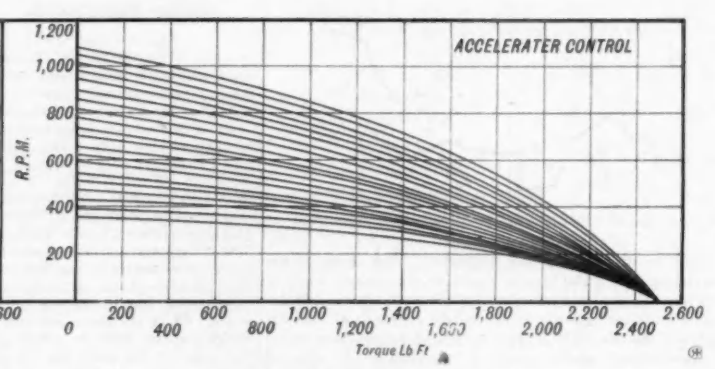


Fig. 6—Accelerator Curves

as shown in Fig. 3, but it was felt that a more substantial arrangement would be necessary in a position so exposed as that of a windlass. The heavy cast iron stool itself forms an effective radiating surface for the small amount of

heat which it is necessary to dissipate. The speed control may be said to be infinitely variable, for whilst the controller gives twelve raising and twelve lowering speeds, the action of the regulating motor gives a gliding acceleration between steps so that the speed steps are not noticeable. As there is also an accelerator of twenty steps which may be used as a fine adjustment of each controller speed, the speed steps possible in either direction may be said to

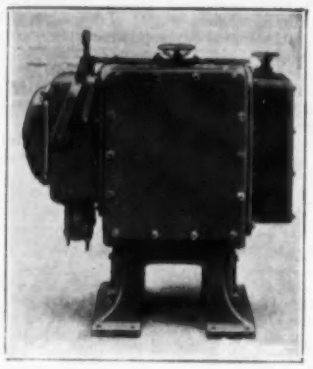


FIG. 7—CONTROLLER

be 240. The controller position determines the torque, whilst the accelerator governs the speed only. The curves Fig. 5 show the effect of speed and torque control by the main controller and the curves, and Fig. 6 the effect of speed control by the accelerator, and when it is considered that the family of curves shown in Fig. 6 can be applied to every curve in Fig. 5 it will be understood that the speed control is very exceptional, and it is to be noticed that in

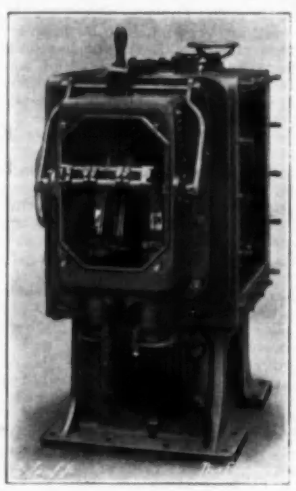


FIG. 8—CONTROLLER WITH COVER REMOVED

Fig. 9 all curves stall at the maximum to which the controller is set. The reason for introducing such an extensive speed range in a windlass or capstan control may not be generally realised, but the makers of the equipment point out that a controller with fewer speeds would cost the same and that the acceleration is accomplished by a low-resistance strip shunting the field coils with less than 1 volt potential difference. It is therefore easy and it costs little to give

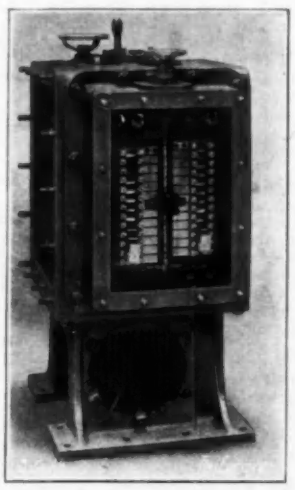


FIG. 9—ACCELERATOR

this great speed range, which meets an important condition both in the case of windlass and capstan. In starting the windlass the accelerator is at slow and the full torque is put on by means of the controller, the accelerator being adjusted to suit the conditions of working, and when the anchor approaches the hawse pipe the acceleration is reduced, which reduces the speed, but leaves the full torque available. The anchor can then be drawn into position, the torque being reduced as it approaches the dead stop, so that all shock is removed from the anchor cables. In the case of the capstan, the torque will be applied by the controller to suit the size of the rope in use, but in any case the maximum torque is limited to 22 tons. All the heavy pulling is done with the accelerator at a moderately slow speed, and the speed need only be increased when necessary for pulling in the light rope.

A general view of the winch is given in Fig. 3. Its motor is of similar design and has similar characteristics to those of the capstan motor. The motor is directly coupled to the worm shaft through a clutch, and under these conditions it is suitable for loads up to 3 tons, but for heavier loads up to 5 tons the motor is de-clutched from the worm shaft and a spur gear is introduced by means of the handle shown. The gear with the cover removed is shown in Fig. 4. The two intermediate spur wheels are mounted on an excentric shaft and are put into gear and locked in position by a 180-deg. movement of the lever in a similar way to a lathe back gear.

Owing to the fact that the Austin winch lifts medium loads at double the speed of that of a direct-current series machine, heavy loads can be handled at good speeds by the introduction of the spur gear. Cargo can be handled by this winch in the same way as it can be handled by a steam winch. Any reasonable speed of raising and lowering can be attained, but the quality which appeals most to stevedores is the slow and flexible motion necessary when stowing cargo or pulling it out of a restricted space. The machines are made at Cathcart under the Austin Macfarlane patents by the sole licencees, Gilbert Austin, Ltd., and the Macfarlane Engineering Company, Ltd., which is jointly interested in the patents, co-operates with the former firm in the design and construction.

The Origin and Development of Heavy-Oil Aero Engines.*

By D. R. PYE, M.A., F.R.Ae.S.

IN aero-engine construction, as in aircraft, the skill of the designer in the economic use of materials meets its greatest problems and finds its highest achievement. It is safe to say that, but for the demands of aeronautics, no engine would be in existence to-day which could generate 500 H.P. at a total weight of less than 1000 lb. By way of illustrating what an economy of material this means as compared with other branches of engineering, one may quote 15 lb. per H.P. as a rough figure for the weight of an average motor car engine at its maximum output.

The idea of a compression ignition engine, using heavy oil, has certain obvious attractions for aeronautical engineers, and in the face of such an achievement in weight saving for the petrol engine, it was but natural that attention should be turned to the possibilities of doing the same thing for engines employing the compression ignition principle; more especially as this type had already proved capable, in its heavy stationary form, of outstanding economy in fuel consumption. The advantages to be gained by sweeping away all the complications of electrical ignition, by the use of a cheaper fuel at a higher thermal efficiency, and by the reduction of fire risks, are indeed worth striving for, and it is not for want of effort that the heavy-oil engine does not yet compete with the petrol engine in aircraft. When we attempt to cut down the weight per horse-power to a point within the limits for air work we are met by very formidable difficulties, and at present the figure is too high for the aircraft builder. Nevertheless, great strides have been made towards the production of a light and efficient prime mover with compression ignition, and even if the research work has not yet succeeded in producing a practical power unit for heavier-than-air craft, it has brought us within measurable reach of doing so.

It is the airship which stands to benefit most by the successful development of the heavy-oil engine, and it is in a position to benefit from the new power unit at an earlier state of the latter's development. We are led to the conclusion, therefore, that although the airship is at present itself an experiment, from the point of view of the heavy-oil engine it might be of enormous value as a laboratory. The airship "R 101," during her successful trial flights, was propelled entirely by heavy-oil engines. The engines were undesirably heavy, even for an airship, but it is fairly certain that the heavy-oil engine will provide a satisfactory practical power unit for airships before long, and before it reaches the aeroplane stage. Its application in this way will provide the necessary conditions for developing and trying it out, under other than ground level conditions, until the more exacting requirements of heavier-than-air craft can be met.

In order to form an estimate of the difficulty of producing an adequately light engine of the compression ignition type we must consider its mode of operation as compared with that of the ordinary petrol engine. It is a commonplace of the latter that improved economy follows steadily upon greater and greater compression of the combustible mixture before it is fired by the spark. The limit to which this compression can be raised depends upon the fuel. The present limit for volatile fuels which are available in quantity may be taken, roughly, as 6 : 1, but even supposing fuels become available with which the detonation difficulty is eliminated, it is not probable that a compression ratio much above 8 : 1 could ever be widely employed. The temperature produced by adiabatic compression of air in this ratio is nearly 500 deg. Cent., which is about the self-ignition temperature of volatile fuel-air mixtures. Pre-ignition will therefore take place at these high ratios in an irregular manner depending upon engine temperatures.

By compressing air only and so eliminating pre-ignition the heavy-oil engine is able to use a much higher compression and expansion ratio, with consequent higher economy. The fuel is introduced at or near the top of compression, when the air temperature has been raised to above 600 deg. Cent., and is vaporised and ignited by the hot cylinder contents. The combustion problem now takes on a new aspect. If the whole of the injected fuel is to be burnt, every particle of it must be brought, in a finely divided condition, into intimate association with its proper quantity of oxygen. This pulverising, mixing, evaporation, and burning of the fuel has all to be achieved in a time which, even in the comparatively slow-running type of heavy stationary engine, is vrey short. It is of the order of one-fiftieth second for an engine running at 300 r.p.m. In the heavy stationary type of engine the pulverisation and distribution of the fuel is accomplished by squirting it in with a high-pressure air blast. The economy achieved in such engines, with their compression ratios of about 15 : 1, is very high, but the weight and complication of the necessary air compressors put them quite out of court, where weight and simplicity have to be considered. On this account a method of fuel injection has been developed which is independent of high-pressure air, the liquid fuel being squirted in as a fine jet or spray under direct pressure from a pump plunger. In these circumstances we are clearly dependent upon either turbulence of the air in the cylinder or upon the penetration of the jet itself, for the proper mixing of the fuel and air. Provided satisfactory mixing and combustion of the fuel and air can be achieved, a compression ignition engine with its high expansion ratio may be expected to consume a smaller weight of fuel per horse-power than a petrol engine, and since the effective weight of power plant is the total weight of engine and fuel, we may allow for this factor of high economy in fixing an admissible weight per horse-power for the compression ignition as compared with the petrol engine. With its certainly attainable consumption of 0·4 lb. of fuel per horse-power hour as compared with, say, 0·55 lb. for the petrol engine, the total weight of engine and fuel would be the same, for flights of ten hours' duration, even if the engine itself weighed 3½ lb. per horse-power, as agninst 2 lb. per horse-power for the petrol engine.

The petrol engine at 2 lb. per horse-power maintains a brake mean effective pressure of 130 lb. per square inch up to speeds of revolution of 2000 r.p.m. and higher, corresponding to mean piston speeds of about 2300ft. per minute. The highest output obtained with direct injection engines in commercial use is of an order corresponding to a B.M.E.P. of 70 lb. per square inch at piston speeds of 1500ft. per minute, and this, be it noted, in comparatively large cylinders.

From these figures we can get some idea of the magnitude of the problem to be faced, for the only hope of reducing the weight-power ratio of such an engine to within the range of possibility for air work must involve an increase of the mean piston speed to about 2000ft. per minute, in smaller cylinders with their correspondingly higher revolution speeds, and we must at the same time maintain a B.M.E.P. of at least 100 lb. per square inch. From an engine of the same size and weight we should then obtain two-thirds of the petrol engine power output, and if we allow ½ lb. per horse-power for the greater ratio of maximum to mean cylinder pressures which is inseparable from a high compression ratio, we arrive at the specified figure of 3½ lb., as against 2 lb. per horse-power.

CYCLES AND MODES OF OPERATION EMPLOYED.

A distinction is drawn in most text-books on the internal combustion engine between engines working on a cycle in which combustion takes place at constant volume—Otto cycle—or at constant pressure—Diesel cycle. In practice no real line of distinction can be drawn. It is true that in the petrol engine, with its ignition timing of 30 deg. before the dead centre, combustion should be very nearly at constant volume; and that constant pressure combustion is approximately realised in some slow-speed engines; but in the high-speed heavy-oil engine we can pass continuously from the one to the other by alteration of the instant when injection of the fuel is commenced, and the point at which this is fixed depends only upon what maximum pressure in the cylinder we are prepared to put up with. From injection just before the dead centre, giving a flat-topped indicator diagram, the combustion can, by a progressive advance of the beginning of fuel injection, be made sharper and sharper, with correspondingly higher maximum pressures, until practically constant volume combustion is attained.

It has been found that the nearer constant volume combustion is approached the better is the fuel economy, as would, of course, be expected, for it means a greater expansion ratio after combustion is complete. Up to a point, too, running conditions as a whole are more stable with early injection and combustion is less sensitive to an alteration of load. How far reliability will be able to tolerate high maximum pressures is a point on which it is too early to dogmatise, but one can fairly argue that the weight/power ratio of an engine, for the same reliability, will move up or down with the ratio of maximum to mean pressures, for the scantlings must be designed to withstand maximum forces while the power is proportional to the mean pressures during the stroke. This ratio of maximum to mean pressure in a petrol engine, apart from detonation, is at most 4 or 5. In the heavy-oil engine it must be at best 7 or 8, and whether this can profitably be increased to 14 or 15, as in the Packard engine, is a question which experience alone can decide.

The first stage in the development of the heavy-oil engine for aircraft was necessarily to prove that it was possible, using the injected fuel principle, to obtain a power output from a given size of cylinder sufficient to hold out the possibility of a power/weight ratio in a complete engine comparable with that of a petrol engine.

It is to the Royal Aircraft Establishment, Farnborough, that we owe the first demonstration that it was possible to obtain a combination of piston speed and mean effective pressure within 20 per cent., at any rate, of the best petrol engines. A full account of these classic experiments will be found in the *Aeronautical Journal*,† and it will be sufficient here to summarise some of the outstanding results. The engine used had a large cylinder, judged by aero-engine standards, of bore and stroke 8in. by 11in., and a maximum speed of 1200 r.p.m., corresponding to a mean piston speed of 2200ft. per minute. The leading results are given below, and from these the dependence of B.M.E.P. and economy upon the maximum cylinder pressure allowed can be clearly seen.

For light-load running a considerable advantage was

* Akroyd-Stuart Memorial Lecture, the Royal Aeronautical Society, Thursday, December 11th, 1930, at the Royal Society of Arts.—Abridged.

† "High-speed Compression-Ignition Engine Research," H. B. Taylor, *Aeronautical Journal*, 1927.

obtained by injecting the fuel earlier, as the amount of fuel injected was decreased. Under these circumstances, of course, an earlier injection was possible without increasing the maximum pressure, and a continuous increase of thermal efficiency was obtained down to approximately half torque. The highest recorded efficiency with the maximum pressure limited to 800 lb. per square inch was obtained at 1000 r.p.m., when the B.M.E.P. was 78 lb. per square inch and the fuel consumption 0·358 lb. per brake horse-power hour, which corresponds to a brake thermal efficiency of 38·8 per cent.

Results Obtained upon the 20T. Engine at the R.A.E., Farnborough, Showing the Effect of Maximum Cylinder Pressure Upon B.M.E.P. and Consumption.

	Maximum Cylinder pressure.	B.M.E.P.	Corresponding fuel consumption.
At 800 r.p.m.	800	123·2	0·392 lb./B.H.P.-hour
,, 800 ,,	650	117·0	0·415 ,, ,,
,, 1200 ,,	800	114·8	0·421 ,, ,,
,, 1200 ,,	650	107·0	0·45 ,, ,,

The results of this research work were found their application in the Beardmore engines of the "R 101." These had a slightly larger cylinder—bore and stroke 8¼in. by 12in.—and were designed for a slightly lower speed; but, as in the Farnborough research engine, the mixing and burning of the fuel and air was by directed fuel spray from a central injection valve. No attempt was made to provide organised air movement in the cylinder. An important difference is that in the Farnborough experiments the fuel injection was controlled by a mechanically operated valve, whereas the Beardmore engine employs a "jerk pump" and a spring-controlled fuel valve which is opened and allowed to close by the rise and fall of pressure generated in the fuel system by the pump.

For a multi-cylinder engine the jerk pump system has great advantages from a designer's point of view, and from that of maintenance. The difficulties inherent in the alternative, *i.e.*, that of opening by means of a cam a valve which admits fuel under approximately constant pressure, arise from the necessarily very small and very rapid movement of a necessarily robust valve spindle. Since the normal lift of the valve is only about 0·020in. and the period of opening corresponds to 15 deg. of cam shaft rotation, it is clear that the cam is very small, and great rigidity of construction is essential. For this reason it is doubtful whether any method of operation, other than by an overhead cam shaft acting direct on the valve spindle, would be as successful as the early experiments with this design. Less direct methods of lifting the fuel valve, more easily incorporated on a multi-cylinder engine, have so far failed to provide the necessary exactitude in the very small movement of the valve.

Research aiming at the development of a high-duty engine employing a pre-combustion chamber has been more extensive in America, under the auspices of the National Advisory Committee for Aeronautics, than in this country. Here, what experience there is has not been encouraging. This system may have certain advantages from the point of view of ease of starting and of control, which are very valuable in the application of the heavy-oil engine in small sizes to road transport when extreme lightness and high efficiency are not required; but it cannot be regarded as more than a temporary expedient in the production of a heavy-oil engine of high efficiency.

The development of the air swirl method is due to Mr. Ricardo in the work he has been carrying out for the Air Ministry in recent years. All the engines in which he has applied the method hitherto have been sleeve-valve engines, on account of the ease with which air motion can be directed through the valve ports, and of the convenience in the form of cylinder head which is allowed by an absence of any valves therein.

The most important work from the aero-engine point of view has been upon single-cylinder units of bore and stroke 5½in. by 7in. Two important points, when one is considering reliability in prolonged service, are, first, the comparatively low oil pressure required in the fuel system; and secondly, the absence of the very fine holes, 10-15 thousandths of an inch diameter, which the directd spray method entails. In Mr. Ricardo's own words, "when working on this system the fuel is injected through a plain single-hole orifice of relatively large diameter, and without any valves or moving part other than the provision of a light non-return valve somewhere between the pump and the injector orifice, merely to prevent air being forced back into the fuel system. . . . A comparatively low oil pressure is required, ranging from 1500 lb. to 3000 lb. per square inch, according to speed, sufficient merely to propel the oil stream nearly to the bottom of the chamber, and since there is no loaded valve it follows that the pressure is controlled entirely by the resistance of the actual nozzle, the size of which is selected to give the necessary penetration. With such a nozzle the jet consists, for some distance, of an apparently solid core of liquid surrounded by an envelope of fine particles."

Two single-cylinder research engines have been used, of the same bore and stroke, 5½in. by 7in., the earlier one designed for a normal speed of 1300 r.p.m., and the more recent model, designed after experience with the first, for speeds up to 2200 r.p.m. Both engines drive their own auxiliary gear, so that the performances given are strictly net.

The maximum horse-power of the first unit, 32·5 at 1300 r.p.m., corresponds to a B.M.E.P. of 119 lb. per square inch, and at this output the fuel consumption is 0·42 lb. per B.H.P. hour. It will be seen that between 19 H.P. and 27·5 H.P., *i.e.*, over a range of B.M.E.P. from 70 lb. to 100 lb. per square inch, the fuel consumption is only 0·355 lb. per B.H.P. hour.

The high-speed engine cannot compete with these fuel consumptions on a B.H.P. basis, but on a basis of indicated power there is little to choose, under optimum conditions.

One may conclude, therefore, that combustion is equally satisfactory at the high speed. Even on a B.H.P. basis the fuel consumption at 2200 r.p.m. is under 0·4 lb. between 26 and 44 H.P., corresponding to an M.E.P. range from 55 lb. to 95 lb. per square inch. Since the mean piston speed at these r.p.m. is 2570ft. per minute, and the engine can develop a B.M.E.P. of 110 lb. per square inch at this speed, the output from the cylinder is almost on a par with petrol engine practice and should provide the basis for a heavy-oil engine well able to compete with its petrol rival, having regard to its saving of 25 per cent. on fuel weight to be carried.

Practical Developments.

Three different heavy-oil engines may be said to have reached, at the present time, the stage of practical development. Each design is the only one of its type, and the three types areas widely different as it is possible for designs to be, so that the position in regard to future evolution is one of exceptional interest. The leading particulars for the three engines are set out below :—

	Beardmore 8-cylinder "in line." Water-cooled.	Junker S.L. 1 6-cylinder, double-piston, two-stroke. Water-cooled.	Packard 9-cylinder radial. Air-cooled.
Number of pistons ..	8	12	9
Bore, in.	8¼	4¾	4 13/16
Stroke, in.	12	8½	6
Swept volume	5129	1739	980
R.P.M. normal	1000	1500	1950
Mean piston speed, feet per min.	2000	2060	1950
Compression ratio ..	12·25 : 1	14 : 1	16 : 1
Normal power	650	600	225
Dry weight	4500	1648	510
Weight per H.P. ..	6·9	3·08	2·26
Cylinder B.M.E.P. at normal power	101	91	94
Maximum cylinder pressure allowed	850	Not given	Over 1200 lb. per sq. in.
Fuel consumption, lb./B.H.P./hour	0·35 to 0·4	0·375 to 0·4	0·35 to 0·4

Any direct comparison of the weight per H.P. figure for the Beardmore and the other two would be misleading without further explanation. Undoubtedly the "eight-cylinder in-line" is essentially a heavy type of engine, with its long crank shaft and crank case, but, in the first place, the Beardmore engine was designed to run at a higher speed, and would give equally good cylinder output under these conditions. Its maximum running speed is at present limited by torsional resonance troubles in the crank shaft. Furthermore, the engine was at first designed with an aluminium crank case, and the experimental engines were built in this material. Difficulties in the production of sound light alloy castings of the size and complexity, combined with the vital necessity of having a reliable engine to propel the airship as soon as it was completed, led to the adoption of steel crank cases in the engines as finally fitted. Reversion to aluminium should be only a matter of development, as also a raising of the rated output to the original figure of 700 H.P., and these two factors between them should at once reduce the weight per H.P. to less than 4.

Each of the other two engines present features of exceptional interest, apart from the general novelty of their lay-out, for each design includes a feature which on a preliminary inspection one would deem likely to prove a source of difficulties fatal to success, and each design, if present reports are to be relied upon, has justified itself.

The production of high M.E.P. on a two-stroke cycle, with its advantages of a working stroke every revolution, depends upon efficient scavenging. The only really satisfactory type is an "end-to-end" scavenge, and this can be easily and simply achieved, without any moving valves whatever, by employing two pistons per cylinder, one of which uncovers the exhaust and the other the inlet ports at the appropriate moment. There is therefore great attraction in the two-piston principle, but also there is great difficulty in the problem of co-ordinating the power from the two pistons. So far as one can see there are three ways of doing this :—

(1) By having two crank shafts geared together, as in Junkers engine.

(2) By having one crank shaft, upon which one set of pistons operates directly in the usual way, and the other set through long connecting-rods.

(3) By having two "swash plates" on one shaft and the cylinders with axes parallel to the shaft between the two.

In the Junkers marine engines method (2) is employed, but for the aircraft engine this has been discarded in favour of (1) on the grounds of weight and also probably of better balancing at high speeds. In face of the severity of the conditions under which it works, it was a bold step to go to gearing, but it seems to have been a successful one. The severe conditions are due to the large torque variation per revolution which is associated with a compression ratio of 14 : 1, but these are, of course, mitigated by the two-stroke method of operation, for with only six cylinders we yet have the same number of impulses per revolution as with a twelve-cylinder engine of the normal type.

The interest of the Packard engine lies not in originality of lay-out, but in the combustion conditions in the cylinders and in the great ingenuity exhibited by the details of the design and in the methods adopted for dealing with the special difficulties of the compression-ignition engine.

We have reports that the Packard engine is being produced on a considerable scale, and that it is to be fitted to commercial aircraft. Technical reports of a reliable nature on its behaviour in service, during the last six months, have been difficult to obtain, and so far no engine has been over on this side of the Atlantic. It is to be hoped that one may be seen here before long.

Future Progress.

Speculation on the progress of future design is made interesting, as we have seen, by the variety of present points of departure. The three types described, moreover, do not exhaust the possibilities, for there still remains the sleeve valve engine based upon the single-cylinder research of Mr. Ricardo. Experience is lacking of the sleeve valve in engines of aircraft scantlings, but in heavier stationary engines running at 700 to 1000 r.p.m. it has proved its reliability and there is no reason to anticipate that it cannot be developed successfully in light-weight engines.

If the sleeve valve proves mechanically satisfactory, then this opens up a very promising line of development for a water-cooled engine; a B.M.E.P. of 90 lb. per sq. in. has been achieved up to 2500ft. per minute piston speed, with a fuel consumption of 0·39 lb. per B.H.P. hour. This represents an increase of cylinder output of 26 per cent. over the Packard performance, with maximum pressures not more than two-thirds as great.

There seems no reason why the Beardmore type of "in-line" engine with one bank of cylinders should persist in the heavy oil any more than it has in the petrol category. Anything which can be done on an eight-cylinder in-line can be done equally on a twelve-cylinder V type, and the necessity of crowding more cylinders on to a shorter shaft is equally imperative from the point of view of reducing engine weight and torque fluctuations. The most fruitful line of development appears to be towards the large power unit for heavy long-range aircraft of moderate cruising speed. Air screw efficiency will, for this, demand a geared engine, and the difficulty of this mechanical problem will be in direct proportion to the fluctuations of torque in the crank shaft.

Progress in this country towards the production of a heavy-oil engine that will lift itself and an aircraft, has been less spectacular than events in Germany and America. I am not at all sure, however, that the methods of steady research may not produce something of more staying power which, like the three-mile runner who allows a competitor to make the pace during the early laps, may turn out to be a winner in the end.

Apart from air-cooled engines, which are as yet at an earlier stage, there are two lines of advance which are being pursued by the Air Ministry, and of which, through the courtesy of the Air Council, I am able to give some account. The first employs the direct spray and the second the sleeve valve and organised air swirl. In each case the engine we are building is a twelve-cylinder V, water-cooled, which necessarily looks more or less like an aero-engine because we have worked upon the plan of following, so far as possible, the lines of a well-tried petrol engine. Basing the design upon single-cylinder research work using the directed spray, the Air Ministry staff at Farnborough have been responsible for designing the special cylinders, pistons, and other gear necessary for converting a Condor engine to work on the compression ignition principle. The work has been carried out with the co-operation of Messrs. Rolls Royce. It is too early yet to say much of the engine as a practical power unit for heavier-than-air craft, but you will, I think, agree that the R.A.E. staff are very much to be congratulated when I tell you that although the engine has only been completed within the last two months, and much remains, therefore, to be found out about coaxing it to give its best performance, it has already shown itself capable of maintaining a steady output of B.H.P. at 1900 r.p.m., and has a net weight, without allowing for water or air screw boss, of 1430 lb., including its starting gear.

The design of sleeve valve engine is also being based, so far as the crank shaft, crank case and auxiliaries are concerned, upon a well-tried petrol engine, the Rolls Royce "F" type. This engine, which is being built by Messrs. Ricardo and Co., again with the co-operation of Messrs. Rolls Royce, will, I hope, be running early in the New Year.

Speculation upon the more remote developments turns naturally to the possibilities of two-stroke operation. In the heavy-oil engine the prohibitive difficulties of the petrol two-stroke have disappeared, and an efficient scavenge provides at the same time the new cylinder charge. End-to-end scavenge is probably essential for an adequate clearing out of waste products. This the Junker design has achieved by the use of two pistons, and apart from this there appear to be two possibilities—either a sleeve valve cylinder with two belts of ports or a cylinder with an exhaust valve in the head, and scavenge ports round the base which are over-run by the piston. Either type should be possible on a radial engine, but if it is to be air cooled, then the sleeve valve is the more problematical of the two, on account of the peculiar difficulties of cooling the re-entrant cylinder head which this type of valve demands. A two-stroke heavy-oil engine is in many ways ideally suited to development in the radial form, for the high maximum gas pressures of the cycle will at each stroke operate to relieve the high inertia forces associated with the radial form, and so will lighten the loading of the big end bearing.

For the development of the double-piston two-stroke, the only alternative to the Junker designs would appear to be the double swash plate. From the drawing-board point of view, this scheme looks extraordinarily attractive, for it means that all the gas forces in the engine would be taken as a simple tension and bending moment in the straight shaft, and the framework of the engine carrying the cylinders is relieved of all major forces. The practicability of such an engine depends, apart from difficulties of detail which may emerge in the design, upon which the friction loss and heating of the oil between swashplate and pads can be kept down to about the same fraction of the engine power as in the familiar crank shaft-connecting-rod mechanism.

Apart from these questions of lay-out and mechanical co-ordination, there is a point of general interest which applies to all future designs of heavy-oil engine. It concerns the combustion chamber. Will the organised movement of air in the cylinder before and during combustion come to be more and more regarded as of vital importance? In my opinion, it will. Efficient combustion must depend upon properly organised movement, either of the air or of the fuel. Movements of the fuel depend upon very high pressures, very small holes and small movements of mechanical parts, accurately controlled. Each of these factors must be maintained without attention for some hundreds of hours, and each is of a kind to be affected by causal maladjustment and by mechanical wear. Air movements, on the other hand, once provided for in the original design, will be unaffected by any of the possibilities incidental to prolonged service.

The possibilities of supercharging a compression ignition engine are as yet almost unexplored, and certainly present a line of research upon the success of which it is interesting to speculate. If organised air movement in the cylinder is to play an important part in future development, then forced induction certainly affords important possibilities over a naturally aspirated engine in the control of air swirl. The temperature rise of the air during external compression, moreover, which is a drawback in a petrol engine, will be helpful in maintaining the essential compression temperature at high altitudes.

Railway and Road Matters.

THE London, Midland and Scottish Company has included in its Bill for the 1930–31 Session application for powers to build a railway 2¼ miles long between two points on the Cheadle branch in Staffordshire.

IN this column of our issue of July 4th last, it was mentioned that the Dover-street station on the Piccadilly and Brompton section of the Underground system was to be rebuilt. It is now stated that a bigger scheme is contemplated, namely, the combination of Dover-street and Down-street stations with one which will have an entrance in the Green Park and be known by that name. It will have another entrance near Devonshire House, in Piccadilly, and there will be a subway under that thoroughfare.

IN the *Railways Newsletter* for December some very interesting statistics are given as to the amount spent by British railways in "Safety on the Permanent Way." Of the 51,000 miles of single railway track mentioned, it should be remembered that this length includes sidings. There are, actually, 20,440¼ route miles of railway, of which 37,203 miles are single track running road, and there are 15,517 miles of siding. The *Newsletter* says also that these cost over £6,500,000 a year to maintain, apart from renewals. That amount, however, is for wages on maintenance; the total cost of maintenance of permanent way in repairs and partial renewals is £9,200,000.

THE death, on December 20th, of Sir Harry Perry Robinson, who was the correspondent on the Western Front for *The Times* during the war, prompts mention of the fact that, in 1887, he founded that enterprising American journal, the *Railway Age*. That paper passed, in 1900, into the possession of Mr. Hugh M. Wilson, and some of our readers may remember that it was the official journal of the International Railway Congress at Washington in 1905. Owing to ill-health, Mr. Wilson sold the property to the proprietors of the *Railroad Gazette* and the combined journal became known as the *Railway Age Gazette*. It is significant that it later reverted to the original and present title of *Railway Age*.

THE Ministry of Transport railway statistics for September also gave the results for the first nine months of 1930, as compared with the same period of 1929. These showed that the number of passenger journeys decreased by 0·9 per cent., the receipts from passengers by 4·6 per cent. and the total passenger traffic receipts by 3·6 per cent. The passenger train mileage rose, however, by 1·0 per cent. The tonnage of freight traffic fell by 6·4 per cent., which included a decrease of 5·8 per cent. in general merchandise, 8·2 per cent. in minerals and classes 1 to 6 of merchandise, and 6·0 per cent. in coal and coke. The freight traffic receipts suffered a drop of 6·5 per cent. Freight train miles decreased by 2·2 per cent.

THE Irish Free State Government has received sanction from the Dail Eireann for the expenditure of £25,000 on the electric traction experiments with the battery invented by Dr. Drumm. The Minister of Industry and Commerce stated on November 26th, when asking for the vote, that they had progressed to a point which enabled them to declare, with considerable confidence, if not with absolute certainty, that a very long life would be got out of the cells. It was proposed to build two self-contained coaches, each accommodating 100 passengers, and to run them over the suburban tracks round Dublin. The coach would be charged in a very short space of time, and the invention would give them the advantage of third-rail electrification at a considerable reduction in the cost.

IT was fifty years on December 21st since a collision occurred on the Midland Railway at Leeds, which, though not of a very serious character, led to one important decision by the Board of Trade. The accident was a head-on collision between two passenger trains, in which three passengers were killed. An outgoing passenger train was ready to leave on the up line, but as a vehicle stood foul on some points they could not be put to normal and, as a consequence, the starting signal could not be operated. Had the signal been workable it would have been seen that the main line points were set for the down line. As, however, the train was dispatched by a hand-signal, the wrong position of the points was not detected, and the outgoing train passed on to the down line and so met an arriving train. When the accident was inquired into by the Board of Trade it was found that since the place was originally inspected, under the Act of 1842, alterations in the road had been made, which had not been offered for inspection under the later Act of 1871, and the Board of Trade then laid down that the change in position of any connection brought it within the Act of 1871, as "an additional line of railway, deviation line, station, junction or crossing on the level," that had to be submitted for inspection.

IN Colonel Mount's annual report on the railway accidents of 1929, he points out that 52 servants were killed whilst working on the permanent way. These accidents are allocated, as to cause, as follows:—Protection inadequate, no look-out man having been provided, 16; look-out man at fault or personally careless, 4; failure of permanent way men to act upon warning received or to comply with regulations, 20; want of individual care in crossing lines, &c., or lack of care on the part of others, 11; accidental, 1. On this particular subject Colonel Mount observes that efforts are continually being made to impress gangers and men in charge with the nature and degree of their responsibility for making free use of protective measures by appointing look-out men. Education in this respect appears to be the only practical solution and continued efforts on the part of the railway companies to accomplish this is considered to be highly desirable. Proceeding, the report says that it is to be observed that a large proportion—over 60 per cent.—of the accidents which occurred arose through lack of personal care. Only by the encouragement of this essential feature and insistence upon strict regard to the safety regulations laid down can a reduction in such cases be obtained. In connection therewith it is satisfactory to find that railway companies are now incorporating, in their lectures to permanent way men, education in safety propaganda, a movement which is worthy of every encouragement.

Notes and Memoranda.

THE great resistance to wear of the diamond die is remarkable. It has been claimed, for example, that 100 to 200 tons of copper have been drawn through a single die with a 2 mm. hole before any alteration in the diameter of the wire has been detected.

FOR the purposes of gauging the flow of the Columbia River, in America, a cable way has been stretched across at The Dalles, Oregon. On this cable, which has a span of 1237ft., and is 1in. in diameter, a cage accommodating two observers is drawn backwards and forwards across the river.

IN the course of a paper read recently before the Institution of Welding Engineers, Mr. C. C. Hall recommended the following solution for removing scale from "18 and 8" chrome-nickel steel:—Water, 50 parts by volume; hydrochloric acid 50 parts, nitric acid 5 parts, restrainer 0·25 part. The bath should be used at a temperature of about 50 deg. to 60 deg. Cent. About 15 minutes' immersion is required.

THE use of zeolite water-softening units in the municipal water treatment plant at Springdale, Pa., has resulted in reducing the hardness of the well water delivered to the consumer from about 20 grains to 4 grains per gallon. Part of the supply is treated so as to produce water of zero hardness, and is then mixed with the remainder, so as to obtain water of sufficient hardness to be satisfactory for household uses. The two units, which have been placed in operation, have a combined capacity of 610,000 gallons per day.

GALLIUM is a greyish-white metal which, in certain lights, shows a bluish-green colour, says A. V. Petar in a report just made public by the Bureau of Mines. The lustre is brilliant and metallic, but tarnishes quickly. The metal is tough, but is soft enough to be cut by a knife. The most interesting property of gallium, however, is the wide range of temperature through which it remains liquid. The melting point is about 30 deg. Cent., and its boiling point is in the neighbourhood of 1700 deg. Cent. When molten, gallium is not unlike mercury in appearance. The specific gravity varies from 5·9 in the solid state to 6·095 when liquid.

AN explosion of a not very spectacular character, but one which involves a good lesson, has just been reported in connection with the failure of a steam-jacketed copper pan in an Ayreshire mill. The inner shell of the pan collapsed through over pressure, but fortunately no one was seriously hurt. The reason ascribed for the accident was a leaky reducing valve. During the normal working of the pan, the leakage past the valve was not of serious import, but as the temperature of the pan increased, the condensation of the steam supplied decreased, and it is to be assumed that the leakage past the reducing valve was then greater than could be accommodated by the relief arrangements, so that pressure accumulated in the pan to such an extent that it failed. It is obvious that either the safety valve system should have been more adequate, or that the reducing valve should have been overhauled more frequently.

A MILL now being built in the shops of the United Engineering and Foundry Company, Youngstown, O., for a plant in the Chicago district will, says *Steel*, roll plates from ¼in. to 1¼in. thick, in widths of 90in. and in lengths ranging from 300ft. to 400ft. Plate mills have been built to handle plates from ¼in. to 1¼in. thick, 210in. wide, and from 50ft. to 100ft. long, but none ever has been built to make larger tonnages of plates of such length as the one now under construction. The output of the mill will be used for the fabrication of electric-welded pipe, tanks, boilers and buildings. The mill includes three stands of two-high rolls, 52in. diameter and 96in. long, and six stands of four-high rolls, 24in. diameter and 96in. long. The entire unit will weigh about 8000 tons, of which about 95 per cent. is cast or forged steel. Six frames, weighing 70 tons each, twelve housings weighing 80 tons each, and six weighing 76 tons each will be required.

AS was anticipated, says the *South African Mining and Engineering Journal*, the lion's share of the Pretoria Steel Works contracts is going to Britain, the firm of Dorman, Long and Co. having been chosen as the pivot. The value of the contracts placed in England is apparently about 1¼ millions sterling, while about half a million will be shared between Germany and the United States. The German firm Demag is sub-contracting for the steel furnaces and two rolling mills. Ashmore, Benson and Pease will build the blast-furnace plant and Woodall, Duckham and Co. the coking and by-product section. There will be one blast-furnace with a capacity of 500 tons a day, and, apparently, two steel furnaces, nominally rated at 200 tons, but capable of 300 tons. The works capacity will be 160,000 tons a year, as now planned, but the various sections will be so designed that extensions can readily be tacked on without interference with current operations. This capacity represents about one-third of the country's annual consumption of steel products.

IN the design of pole lines to carry electric wires or cables, it is customary to use working stresses for poles of green or soaked wood, and a report on tests at the U.S. Forest Products Laboratory, Madison, Wis., indicates that this practice is correct. It is true that when the moisture has decreased below the fibre-saturation point, which is about 25 per cent. of the moisture content, there is a marked increase in most of the strength properties of the wood. But for pole lines it is assumed that although the poles may have gained strength through seasoning before installation, they will become sufficiently wet near the ground line to raise the moisture content above the saturation point, and thus lower the strength correspondingly. That such excess moisture does occur near the ground line of poles and fence posts at least during part of the year, and in practically all parts of the country, is shown by the report. The calculated point of maximum stress in a pole is often above the ground line, but experience shows that failure is most likely to occur at the ground, so that it is advisable to take the working stress which conforms to the wet condition of the wood at the ground line.

Miscellanea.

A WIRELESS telephone service between Java and Australia has been opened.

AN extensive oilfield is said to have been discovered near Kalonti, on the Chinese Eastern Railway.

A SEAM of coal 12ft. thick at a depth of 136ft., and an underlying one of 5ft. at 183ft., have been discovered by boring at Coalbrook, in the Heilbron district of South Africa.

NEW YORK has initiated an elevated highway on the West Side and the columns and footings have been so designed that a second storey may be added in the future if found necessary.

WORK is about to be started on the construction of the seventh unit of the Gatineau hydro-electric power plant in Ontario. Like its predecessors, it will generate 34,000 horse-power.

THE first unit of the Stave River hydro-electric plant of the British Columbia Electric Railway Company was put in service during last month. It is of 47,000 horse-power, and is to be followed by four other units of the same size.

ACCORDING to the *Manchester Guardian Commercial*, Mr. Mouat Jones, head of the Manchester College of Technology, will shortly visit Russia to act as adviser on technical education to the Soviet Government. Mr. Jones, who is a distinguished scientist, will sit on a committee, together with American and German experts.

A CONTRACT has recently been entered into by the Cities Utilities, Ltd., to supply the city of Regina, Sask., with natural gas from the Alberta fields. Work will be begun immediately on a project involving the construction of a pipe line from Kinsella field, the western extension of Wainwright, to Regina, a distance of 357 miles, which will entail an expenditure of 20,000,000 dollars. The company also contemplates a further extension of 32 miles to connect with Moose Jaw.

THE Danish State icebreaker "Storebjoern," recently launched by the Aalborg shipbuilding yard, is one of the most powerful icebreakers in North Europe. It has a length of 55 m., a beam of 15 m., and a depth of 7·3 m. Its three screws, two aft and one fore, are driven by three engines with an aggregate of 5400 H.P. Oil-firing will be used, and the tanks will hold enough fuel for three weeks. The crew will consist of forty-five men and the boat will be completely finished next February.

WITH the berthing on December 13th of the steamer "Ebano" with 2500 tons of molten bitumen, a new traffic has been inaugurated at Preston Dock. Making her maiden voyage, the vessel brought her unusual cargo from Germany. Plant has been erected at Preston at a cost of £35,000, and by carrying the liquid bitumen oversea in heated tanks, pumping at Preston into heated steel containers, and then carrying to the consumers in heated lorry tanks or railway truck tanks, the material, used mainly for road-making, is ready for handling on arrival.

NEW petroleum refineries have just been opened at Santa Cruz de Teneriffe, Canary Islands, with a present capacity of 5000 barrels daily. The refinery, which is owned by the Compañia Española de Petroleos, covers an area of 2,150,000 square feet and is connected with a loading wharf by a pipe line nearly 3 miles long. Although it is not yet working to its full capacity, large consignments of petrol are already being despatched. The refinery will also supply the oil requirements of the islands. The plant is equipped with the most modern apparatus and will employ 150 men, working three shifts of eight hours each a day.

THE *Deutsche Bergwerks Zeitung* reports that the negotiations between the Rumanian and Yugoslav Governments on the construction of a bridge over the Danube have resulted in the decision that the bridge shall be partly constructed on account of German reparation deliveries in kind. The bridge will cost 25,000,000 marks, which is to be borne equally by Rumania and Yugoslavia. It was originally proposed that the site should be between Kladovoc-Turn-Severin and Orsova, which was chosen chiefly for strategical reasons, but that proposal has been abandoned, and the bridge will be built between Brza Palanka in Yugoslavia and Triganos in Rumania.

THE parliamentary plans for the new bridge at Kincardine have now been deposited. This bridge will cross the Forth and is a steel bridge having fourteen approach spans with an opening swing bridge giving two clear openings of 100ft. each, and was designed by Sir Alexander Gibb and Partners. The total length of the bridge is 2400ft. Two projects have been under consideration: one a bridge at Alloa and the other at Kincardine, and the engineers to both schemes agreed that on the balance of financial and traffic considerations the Kincardine site was to be recommended. The total cost is in the neighbourhood of £300,000 and the building of the bridge in connection with the official programme for unemployment relief will be of great help to the steel industry.

THE Eriksberg shipyard at Gothenburg is to build a new icebreaker for the town of Gothenburg. The vessel will not be quite as large as the largest of the Stockholm icebreakers, but the difference will not be very great, since it will have a length of 56 m., a beam of 15 m., and an engine power of 3700 H.P., compared with the Stockholm icebreaker's 60 m., 17 m., and 4000 H.P. Like the Stockholm ship, it will have machinery both fore and aft. It is to be delivered by the end of 1932. On the completion of the new icebraker, which proved necessary owing to the fact that the Stockholm icebreakers, and the big Government-owned icebreaker were so often entirely engaged in dealing with ice in the Baltic and the Sound, Sweden will be fairly well prepared to deal with any ice difficulties arising on her coasts. Moreover, another Government-owned icebreaker is to be constructed in the near future. The naval authorities have just asked for authorisation to invite tenders from Swedish, possibly also foreign, shipyards for its construction, an allowance for which was granted by the Riksdag early this year. The naval authorities propose that the ship should be equipped with Diesel-electric machinery.

ROPEWAY AT THE OIL WORKS OF THE AGWI CORPORATION LTD., FAWLEY, HANTS

MESSRS. R. WHITE AND SONS, WIDNES, ENGINEERS

(*For description see page 696.*)

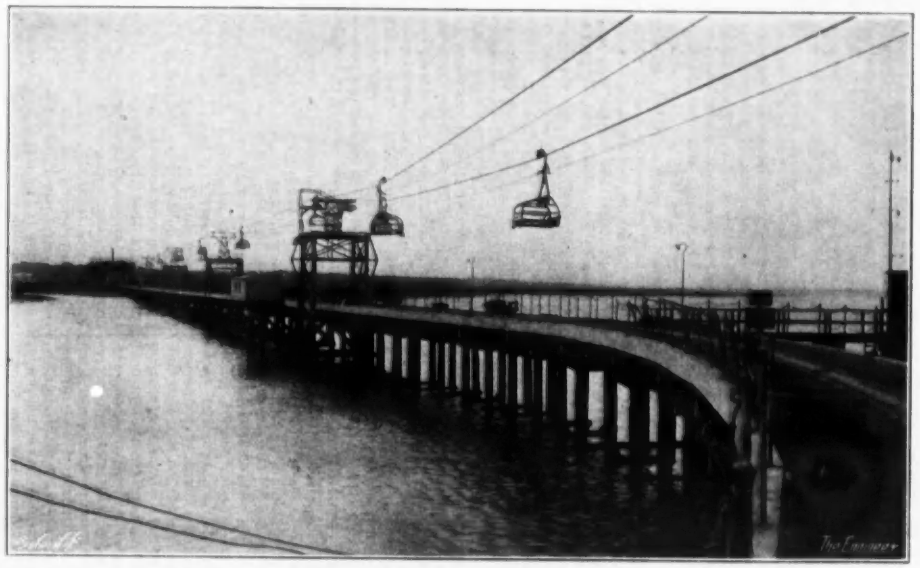


FIG. 16—SEA ROPEWAY FROM JETTY

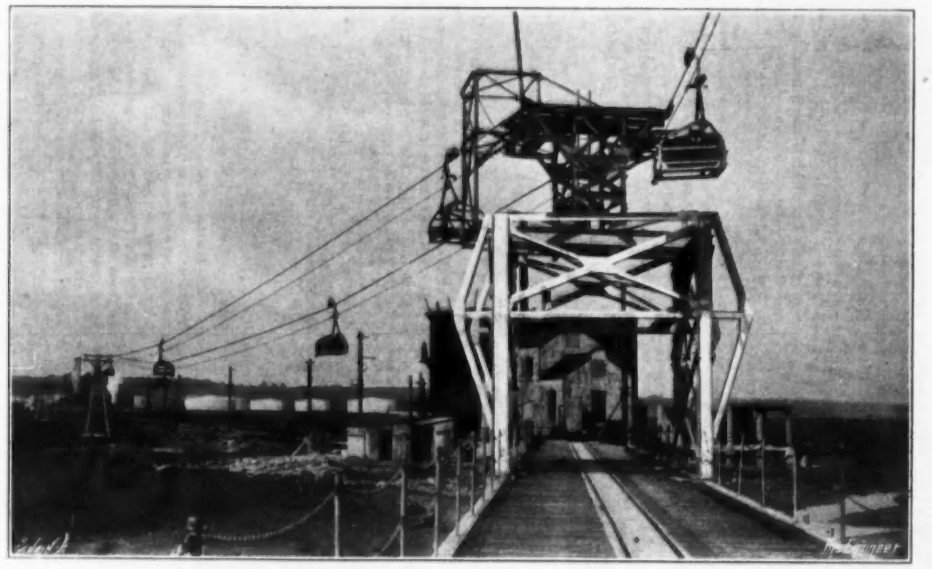


FIG. 17—AUTOMATIC ANGLE STATION AT POINT D.S.

FIG. 18—FIRST SECTION OF SEA ROPEWAY

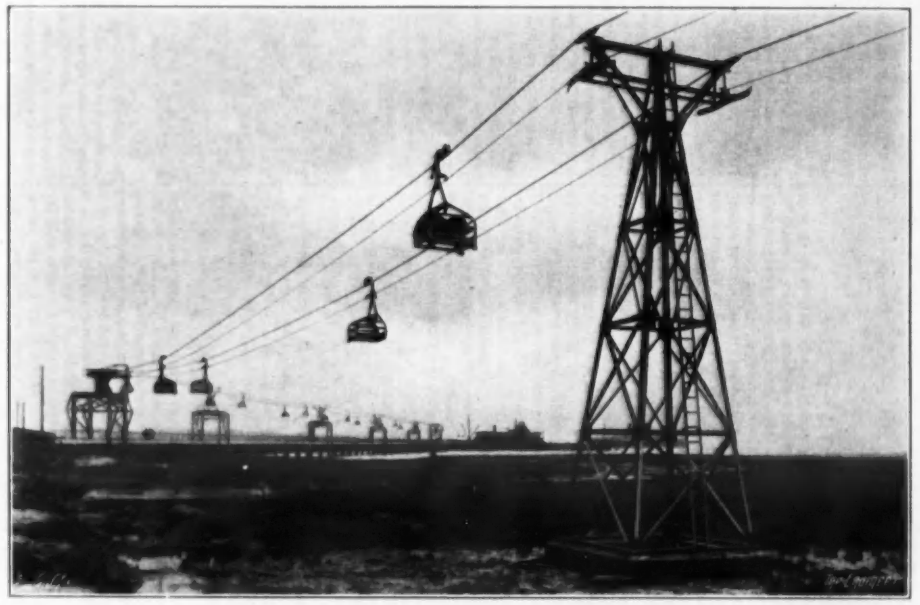


FIG. 19—SEA ROPEWAY LOOKING TOWARDS JETTY

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The Metallurgist.

THE DECEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

VOL. CL No. 3911

DECEMBER 26, 1930.

Obsolescence.

ON Tuesday, December 16th, Major F. L. Watson delivered a Chairman's Address to the Yorkshire Branch of the Institution of Mechanical Engineers. All who read the excerpts from it which we print on another page will recognise at once that it is outside the ordinary class of such addresses in that it is concerned with large aspects of industry, rather than with technicalities and special occupations. Major Watson is, by long experience, an expert in machine tool equipment, but he has also devoted study to the economics of the engineering trades, and holds strong views about the functions of Governments in their relation to industries. He opened his address by drawing an apt distinction between dreams and visions. "A dream," he said, "is really a reflection of the past, having its birth in memory more or less confused. A vision is a glimpse of the ideal, which may become the actual." It is against the persistence of dreams and the absence of vision in the handling of industry that he girds.

A characteristic of British machinery is its longevity. We pride ourselves on the fact that it never wears out. We boast of the magnificence of the workmanship, the excellence of the material, and the generosity of the design which result in almost immortality. Major Watson would, we suspect, class such thoughts under his definition of dreams—they spring from the past. But as an old Bucktonian he hesitates to assert that machines should be worn out in the normal course of ten years. Recognising that a first-class machine may have a useful life of thirty years, he aims at compressing every three years in that cycle into one by working factories continuously for 144 hours a week. That is, he admits, an ideal—something to place in his class of visions. It may be realised under exceptional circumstances — sectionally during a boom, nationally during a war—but the fundamental length of the working week will always remain a subject for debate. Ought we to say that the week has 144 hours—or even 168—and that during any hours not used capital in the form of machinery, plant and buildings is idling; or ought we to accept the standard set for the industry at any period—forty-seven in the engineering trade at the present time—and estimate our use of capital as a hundred per cent. if every machine is being used for every moment of that week? A similar problem occurs in thermo-dynamics, and it is now admitted that it is not fair to estimate efficiency on a purely theoretical basis, but by consideration of the limits set by unalterable conditions. If we take this lower scale in workshop finance, then the right course would be to design machines that would be worn out in, roughly, one-third of the present time. Unfortunately, that condition is only attainable in certain cases; in others, as Major Watson points out, "it is not practicable for machines of high power and accuracy—they would not be good enough when new, and their maintenance cost would be excessive." But is it necessary that a machine should be worn out before it is rejected? We have all heard of American firms which rejected plant less than a year old because newer designs had rendered it relatively inefficient. What would appear to be needed is more drastic writing off of the original value. The official rate for income tax assessment is now 5 to 7½ per cent. on the preceding year's value. If that figure were raised to 10 per cent. on the *original value* there would be a lessened temptation to keep machines that were more than ten years old, even though they were good for another thirty. But such a course would call for a deal of Major Watson's vision; it would be too much to expect from the average financier or from the financial half of the engineer's brain. Yet it might be the best policy, not only for the factory concerned, but for the nation as a whole. "The obsolete shop," says Major Watson, "is injurious to the whole industry," and adds: "It competes for business by cutting prices below the economic level." In that argument there seems to be some confusion of reason. If the obsolete shop can produce more economically than the up-to-date shop, then, in that sense, it is more efficient, and obsolescence is a virtue rather than a defect. The object of every renewal of machinery should be reduction of cost without loss of quality or reduction of total profits. If it cannot achieve that object, if the old machinery can be operated as cheaply as the new, if there is no acceleration of output accompanied by reduced selling cost, it is difficult to see why, regarded economically, the old plant should be rejected. We agree with Major Watson that the obsolete shop is injurious, but not because it causes the cutting of prices, but because it should be less efficient than the new. The slogan can surely never run, "Put down new machinery and keep the price up," but rather, "Put down new machinery and undersell the shop that retains the old."

We have touched upon little more than one facet of a sparkling address; we wish we had space to discuss some of the other subjects which Major Watson placed before his audience. There is, for example, the question of expending capital in the early stages of a slump in preparation for the returning tide, or that of a cut-throat "fiscal system devised a century ago as a weapon for the destruction of the political power of the landowners," or some common-sense reflections upon rationalisation and the "myth of the Superman." In every word of his address Major Watson showed himself a fine exponent of the "straight left." It is refreshing and stimulating to read, and on many points will provoke discussion.

Grock.

AT this season the mind is predisposed towards Grockishness. Though seriousness is thrust upon us by contemplation of, perhaps, the worst year that the engineering industries can recall and by anxiety for the months immediately ahead, yet we do try, at least, for a few days, to live up to the old adage about the benefit of a little folly now and then to the wisest men. Indeed, one might go a step further. Into his grimmest tragedies Shakespeare introduced comedy. Some say that his fools and his clowns appear only to make the contrast greater, but is it not possible that the great poet knew that tragedy unmitigated by some lighter relief fails of its purpose? The mind becomes inured, stupefied, irresponsive under the succession of fell blows. It loses its power of action, its ability to measure, its sense of perspective. All things

become dark shadows against a flat grey background. Courage is lost in despair and the will to take a brighter view, to see events in their true proportions is killed. Hence every now and then his fools come upon the stage, slash the grey gloom to ribbons, and restore sprightliness to the spirit. There is much to be said for the transference of that method from the strutting stage to the common affairs of life, and so for our last word of the old year we turn to thoughts of Grock—the Clown.

But it is of the wisdom, not the folly, of Grock that we think. We recall how often Shakespeare puts wise sayings into the mouth of fools; how often with him, as with Molière, it is the clown who gives us a crystallised truth. After his recent retirement—a "theatrical retirement," let us hope—Grock was interviewed. According to one paper, he said: "A successor? I have none. Individuality is everything in my particular metier. My own secret? Hard work is everything. But there is something more to it. As I have said elsewhere, I have known clowns who are as good as I am, if not better, but I have never known any *who knew how to get on as well as I did*." We have underlined a few words. Every single one of us has felt just what Grock expressed. We have all seen men that were no better engineers than ourselves going further than we could go. There are men now at the top of the tree who make us wonder how on earth they got there. They do not seem to us to have any particular and exceptional ability in their profession; they make as many mistakes as other men; they talk platitudes. We are tempted to say that they were given opportunities which were denied to us; that we have never had the chances that they had. Yet, as often as not, when we look back over their lives, we find that, in fact, they made their own way, often against adversities. How did they do it? They will tell you themselves, in all probability, that hard work was the key to their success. Grock knows better. If hard work alone was sufficient there would be more "star turns" in every profession. There are thousands upon thousands of men, young and old, who are absolute addicts to hard work, but the world will never hear of them. They plod along upon a useful way; the world accepts their work and forgets from whom it came. Grock knows clowns who are as good as and even better than himself, but he has never known any who knew how to get on as well as he did. There is something more to it than just hard work. What is that something? Is it something that we could teach in our schools and colleges and don't; or is it something that is born in certain men and can never be acquired? Those are questions that it would be really useful to answer; problems which modern psychologists are trying to solve by scientific methods. Our own view is that, in some way, it is connected with what is called the "human touch." Yet there is embarrassing diversity in its manifestations. One man mounts the ladder by churlishness. He seems to despise his fellow men and tells them he does so in as many words. Another is all composed of kindliness and friendliness; never rude or gauche. Another nourishes unconventionality, whilst a fourth is propriety personified. There would seem to be no rule for successful personality. But we think it may be found that in the methods of all great men there is some play upon human emotions and it is in that that their individuality, or personailty, or whatever it may be called, appears.

There is much in such considerations that applies to engineers. We cannot but recall that civil, as distinguished from military, engineering sprang from "base mechanics." For many years it was a handicraft and little more. The men who pursued it had little education and less cultivation; they were diamonds of the roughest. By slow degrees it has raised itself to a higher plane. It is, now, in part a science and is on the way to be regarded with no less social respect than the church, the law, and medicine. But much remains to be done. It was long recognised that in the older professions the human touch was essential, and at last employers are beginning to see that it is just as necessary in engineering. Every now and then offence is given by advertisements which offer absurdly low salaries to engineers. That is because the old standard of evaluation still prevails. The type of man that is wanted is not worth more in the market. He has the same amount of knowledge that thousands of others have; he can do the work just of an engineer, and those who are seeking his services do not expect more. We might compare him to the stage carpenter; he has to prepare the scene for others to act upon; he is not expected to get across the footlights. Such engineers there must always be, but if engineering is to reach the social status that it merits by its usefulness, if engineers are to play a larger part in the affairs of the world, it will need an ever-increasing supply of men who by cultivation have acquired the human touch and by determination have mastered the art of "getting on" by its application.

Literature.

An Early Experiment in Industrial Organisation; Being a History of the Firm of Boulton and Watt, 1775–1805. By Erich Roll, B.Com., Ph.D. London: Longmans, Green. 1930. Price 15s. net.

Surely the word "experiment" is a misnomer to apply to a firm that had an actual career of 120 years, and is, in fact, still in existence—a *pioneer* firm, yes! May we also correct the author's statement in the preface as to the history of the documentary matter on which this volume is mainly based—that now in the Birmingham Reference Library. Credit for its preservation is due to Mr. George Tangye, who bought it in 1895 and kept it at the Cornwall Works, not at Heathfield, till presented to the Library. The author would have been well advised to have deleted the introductory matter on the steam engine, and he would then have avoided giving further currency to the unfounded statement that Savery took out with Newcomen in 1705 a joint patent for the atmospheric engine. There are other small blemishes in the work that the author would have avoided had he submitted his MS. to an engineer.

Mr. Roll brings out with great clearness and full documentation the part that Matthew Boulton played in bringing James Watt's engine before the world. From the beginning of their partnership in 1775 and for twenty years onwards the firm acted much as does a consulting engineer to-day, which, we may add, had been at that time the practice of engineering firms for at least sixty years. That Boulton intended from the first to manufacture engines is clear, but his commitments in many directions precluded him from doing so. Hence only complicated or difficult parts like the valves were made at Soho. As the date for the expiry of his patent for the engine—1800—drew near, Watt, satisfied with his gains, and indeed tired of the engine, gradually withdrew from business, while the coinage of money became the hobby of the indefatigable Boulton. By this time the financial situation was quite changed; money was plentiful, and the sons of the two partners, James Watt, jun., and Matthew Robinson Boulton, had been brought into the business, with the result that a new works—the Soho Foundry—was planned and executed. Routing of the work to be done was kept in view, plant was designed and made, specialisation of workmen was fostered, fresh methods of remunerating labour based on close records of predetermined speeds and feeds were introduced, costing books were kept; in fact, there is nothing in the detail of the most progressive factory of to-day that the two sons—and we believe that James Watt, jun., was the guiding spirit—did not anticipate at Soho. When the transformation from a state of monopoly to one of competition took place in 1800, the business with its inherited skill and new organisation was in an unexampled position to take advantage of the increased demand for engines. The prestige of the firm enabled it to command bigger prices than anyone else, and, in fact, its period of greatest prosperity set in. All this and more the author brings out with such skill and literary ability that he may be said to have written a second epic of the firm of Boulton and Watt.

Electrical Power Transmission and Interconnection. By C. Dannatt and J. W. Dalgleish. London: Sir Isaac Pitman and Son, Ltd. Price 30s.

The aim of the authors of this book is to present material which will form a complete introduction to the electrical aspects of power transmission and interconnection. The subject is treated on a quantitative basis, and descriptive matter has been reduced to a minimum. Familiarity with the algebra of complex quantities is all that is required to follow the methods used in the book. While it has been necessary to present matter that is obtainable in other works, an attempt has been made to present it in a new form, guided by the author's experience. Analytical methods involving the use of symmetrical components and the representation of power as a vector quantity have been introduced where the treatment of a problem is simplified by these methods.

Although no claim is made to the introduction of original matter, frequent references are made in the book to the authors' own work. In an interesting Introduction to the book the authors discuss the relative merits of A.C. and D.C. transmission, and express the opinion that although the latter is not at present practicable, it may come into use in due course. After this introduction the authors consider fundamental electrical constants of overhead line conductors and underground cables, the special problems of which, such as heating, are fully discussed. Another interesting and instructive chapter is that on corona discharge, a phenomena which, generally speaking, only assumes practical importance on lines operating above 66 kV. Network theory forms the subject of the next chapter, which is mainly devoted to the discussion of the theory of a network in the steady state condition. Students are advised thoroughly to master the ideas presented in this chapter, as they form the basis of most of the later work on line and system performances. A chapter on line calculations and system performances is really an extension to Chapter II., which shows how the fundamental electrical magnitudes of transmission lines may be calculated from a knowledge of their dimensions and materials of construction, and the section on line calculations and system performance shows how to calculate from these magnitudes the performance of the line under various operating conditions.

In dealing with the calculation of interconnected systems, the authors embark upon one of the most complicated problems with which the electrical engineer meets, and the difficulty of treatment increases rapidly with the number of stations involved. The authors discuss what they consider to be the best methods of tackling the problems which arise, and indicate under what conditions each method is likely to be useful. Equally interesting and instructive is the chapter on power limit and stability in transmission systems, in which it is shown that the fundamental power limit for A.C. systems in synchronous operation is the power at which synchronous apparatus in the system drops out of step when the power is added so slowly that power transients may be neglected.

After considering symmetrical components and short circuit calculations, the authors turn to the important matter of the interference of power lines with communication circuits, a matter with which telegraph and telephone engineers are very much concerned. Other chapters deal with the experimental study of networks, earthed and insulated neutrals, and transient voltage phenomena. It will be seen that the volume covers a very wide field, and in view of the large amount of electrical transmission work being carried out in this country at the present time, it can scarcely fail to serve a useful purpose.

BOOKS RECEIVED.

Mechanical World Year Book, 1931. London: Emmott and Co., Ltd., 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

Automobile and Aircraft Engines. Second edition. By A. W. Judge. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, .WC. 2. Price 42s. net.

Principles of Engineering Thermodynamics. By P. J. Kiefer and M. C. Stuart. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 22s. 6d.

Richtlinien für geschweisste Gasrohrleitungen von mehr als 200 mm. Durchmesser und mehr als 1 atm Betriebsdruck. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7.

The Colliery Manager's Pocket-book, Almanac, and Diary, 1931. Edited by H. Greenwell. London: The Colliery Guardian Company, Ltd., 30, Furnival-street, E.C. 4. Price 3s. net.

Grundlagen, Mittel und Beispiele zweckmassiger Werkstattmessverfahren. By Ober-Ing. Th. Damm. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 4.75 marks.

Craftsmen's Measures in Prehistoric Times. By L. MacLellan Mann. Glasgow: The Mann Publishing Company, Ltd., 183, West George-street. Price, cloth cover 5s. and paper cover 3s. 6d. net.

The "Practical Engineer" Mechanical Pocket-book and Diary, 1931. Edited by E. G. Beck, A.M. Inst. C.E., &c. London: Humphrey Milford, Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 2s. 6d. net.

The "Practical Engineer" Electrical Pocket-book and Diary, 1931. Edited by Conrad Arnold, A.M.I.E.E. London: Humphrey Milford, Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 2s. 6d. net.

A.S.T.M. Standards, 1930. Part I., Metals; Part II., Non-metallic Materials. Philadelphia, Pa.: American Society for Testing Materials, 1315, Spruce-street, United States of America. Price, Part I., 9.00 dollars, Part II., 9.00 dollars net.

Vollständige Zahlentafeln und Diagramme für das spezifische Volumen des Wasserdampfes bei Drücken zwischen 1 und 270 atm. By Dr.-Ing. H. Speyerer and Dipl.-Ing. G. Saurer. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 2.50 marks.

Obsolescence and Organisation.*

By Major F. L. WATSON.

The most important factors in industry are brains and machinery. Labour and capital are equally unproductive unless the one is directed by brains and the other embodied in machinery. Machinery, under present-day conditions, is obsolete long before it is worn out. The income tax allowance of 5 to 7½ per cent. per annum upon last year's value is quite inadequate, and an industry which takes as profit everything beyond that figure is not really maintaining its capital intact, although the law says that it is.

Whilst the wearing out of machines proceeds more or less steadily in proportion to the time they are

* Chairman's address, Yorkshire Branch, the Institution of Mechanical Engineers, Leeds, December 12th, 1930.

working, obsolescence proceeds usually by jumps, is irregular in its incidence, and occurs whether the machine is working or standing.

A machine becomes obsolete:

(1) When a new machine is produced which will do the same work at a lower total cost.

(2) When the product of the machine is displaced in the market by another product for which the machine is unsuitable.

(3) When the user of the machine makes an improvement in the product for which the machine is not adaptable.

There are, besides, changes of taste or fashion in the design of machines, particularly of machine tools, on the strength of which a machine is sometimes called obsolete when its productive value is not in the least affected. From this cause a machine may become unsaleable when it is not truly obsolete.

As one or more of these causes may operate at any time, and with or without notice, it is not possible to do more than arrive at an arbitrary figure for the average economic life of machinery, having regard to known conditions.

It will not be overlooked that a whole factory may become obsolete, independent of the condition of its machinery, if it is not practicable to modify its layout and arrangements for internal transport to meet up-to-date systems of management and productive methods, or if such modification is not undertaken in time. This can be guarded against by elastic and adaptable design in laying out a new factory. But external changes, such as transport developments, may render the position of the factory obsolete, and political and economic changes may have the same result.

Roughly, machine tools of a good class are obsolete in an average of ten years, are worn out in an average of 30 years, and are written down to scrap value under income tax rules in about 50 years. The problem is to bring the periods of obsolescence, of wearing out and of writing off to the same figure.

Under the normal working week, machinery is used for 47 hours out of every 168, or, omitting Sundays, every 144 hours. It has been suggested that machines should be built to last only 10 years; but this is not practicable for machines of high power and accuracy—they would not be good enough when new, and their cost of maintenance would be excessive.

The ideal remedy is to work machinery for 144 hours a week and wear it out in 10 years instead of 30 years. The effects would be:

(1) The capital locked up in machinery for a given output would be reduced to one-third.

(2) The demand for renewals on a given output would remain constant after a transition period—one-third of the number of machines being renewed three times as often.

(3) The number of people employed for a given output would not be affected.

(4) Capital would be turned over three times as rapidly.

(5) Shops would be always approximately up to date in equipment.

A reasonable basis for income tax assessment and balance sheet figures alike would be an allowance of 10 per cent. per annum on the original cost—wiping it out in 10 years—and a complete wash-out of any machines scrapped and replaced earlier.

The existence of the obsolete shop is injurious to the whole industry. It competes for business by cutting prices below the economic level, always hoping for better times, and preferring slow extinction by annual losses to a recognition of the fact that it is dead.

The disposal of obsolete plant is also worth considering. When replaced, it is commonly not broken up, but sold at scrap price. If the rejected plant comes into the hands of a competitor, it bears so low a capital charge as to mask its higher labour cost; but obsolescence is merely spread from the original shop to another.

Immense injury was done to the engineering trade by the disposal of Government plant after the war, and many shops were filled up with obsolescent tools, to the no small advantage of astute dealers. The Germans, whose munition plants were forcibly broken up under the Peace Treaty, reconstructed their shops with up-to-date plant.

These arguments fairly cover the question of obsolescence in productive machinery. The technical questions involved present no difficulties which engineers cannot meet and overcome. They leave us, however, face to face with a far greater difficulty; that of obsolescent minds in control of organisations of Labour, Capital and Government.

In times of good trade, when prices are high, capital expenditure is freely undertaken, shops become congested with work and delays are unavoidable. The new plant is ready for use when the tide begins to recede and increased plant coming into production accentuates the slump. If capital were made available and orders placed early in the slump, the new plant would be ready for use on the upgrade of demand, less capital would be required on account of the lower prices prevailing at the time of ordering, unemployment would be largely avoided, and the violent oscillations to which we are accustomed would be damped out.

We have reached a stage in which the advancement in quality of material and in mechanical processes has become continuous, and when no improvement need be delayed for want of tools and methods. The vital condition of progress to-day is that capital should be made available for the right objects and at the right time, and its dissipation on the wrong objects and at the wrong time should be stopped. And when capital has been so invested, it should be protected by a liberal obsolescence account, so that it is no longer taken out in dividends not really earned, nor seized by the Exchequer under the present indefensible Income Tax Rules.

Now it is inevitable that the party who finds the money, whether it be a capitalist, a financier, or a Government, will have the final word in business. That is a fact, and engineers do not quarrel with facts. But if these higher authorities are going to make a proper use of the work of the engineer, it is up to them also to make use of his mind and to grasp his point of view. Unless there is free play and financial support for constructive vision, we shall continue to fall far short of the services to humanity which we are capable of rendering. If the world's purchasing power is too small for the world's production, it is not because production is in excess of needs. It is because distribution, depending on finance and government, is not organised to keep pace with production.

In the obsolete mind, modern industry, with its widespread dependents, is not distinguished from the Eighteenth Century landowner or the Nineteenth century mineowner or cotton spinner. A fiscal system devised a century ago as a weapon for the destruction of the political power of the landowners is maintained to-day as an article of religion for which no reason need be advanced, and having an authority similar to Moses' two tables of stone. If the obsolete theory of taxation now current is worked out to its logical conclusion, and if unlimited public expenditure is to be covered by unlimited imposts on industry and on the capital engaged therein, it is only a question of time for this whole island to become obsolete as a locality in which industry can be carried on.

Rationalisation is a very necessary movement; but all is not rational that goes under that name. I take rationalisation to mean securing the most economical output from an industry by concentrating each type of product in a factory organised, staffed and equipped for its special purpose, and cutting sales cost by removing useless competition. Henry Ford goes to the root of the matter when he says "Efficiency is merely the doing of work in the best way you know, rather than in the worst way." It is not rational to combine a group of factories, each of which is making too many varieties of goods, and whose staff is trying to do too many different jobs, into one huge factory, possessing the same chaotic qualities. Neither is it rational to take a dozen factories each staffed by people who know their particular job and place them under the control of a board which knows nothing about any of them, and whose consent must be obtained before any one of the dozen can move. To-day's condition of existence is, that everyone, even boards of directors, must know their own job and do it. The myth of the Superman, or Born Organiser, which started during the war and reached its zenith about 1920, is itself obsolescent. It is no longer quite accepted, that success in organising multiple shops, or in selling whisky, or in writing articles for the popular Press, is evidence of ability to control a number of highly technical businesses.

We hear a good deal to-day about the effect of rationalisation on unemployment, of the manual kind which is registered by the Labour Exchange; but very little about unemployment of technical staffs. This is a matter which touches the Institution very closely. Reductions of staff must necessarily follow from fusions, with results which are hard on individuals, and which may be very bad for industry. Obviously, if six organisations having staffs of one hundred each, are to be fused into one having a staff of, say, two hundred and fifty, three hundred and fifty men are going to be thrown on to their own resources, many of them at a time of life when their mental powers may be at their highest value, but, owing to a prevalent convention, they are too old for fresh employment. There is no "dole" for these men—their votes are not worth buying—and in many cases their savings are wiped out in the process of rationalisation.

SIXTY YEARS AGO.

THE siege of Paris had yet to run another month. Hunger was beginning to be felt in the city, but there were no signs of any falling off in the determination of the Parisians to resist the enemy or, indeed, of the whole of France to continue the war into which their erstwhile Emperor and his advisers had led them. In our issue of December 30th, 1870, we reported that Remington, the American rifle-maker was about to establish a line of steamers between Southampton and Bordeaux in order to expedite the delivery of arms and ammunition to the French Government. It was anticipated that for many weeks to come the firm would land in France 20,000 rifles every ten days, with about 300 rounds of ammunition for each weapon. Six weeks on, France, it was said, would have a million men armed with breech-loaders of one kind or another, and a month later she would have one and a-half million breech-loaders in reserve. Our correspondent in Paris sent us his usual letter by balloon post. It was chiefly concerned with the manufacture and performance of a new design of rifled breech-loading gun, with a useful range extending up to 5000 m. He also gave a graphic description of the defensive works which the Prussians had raised at Choisy-le-Roi, to which place the French had recently made a sortie. He reported that the enemy had made use of even the tombstones from the cemetery in the formation of a barricade to protect his batteries. Of particular interest was a letter which we published in our correspondence columns from J. Scoffern, M.B., of London. He was attached to the ambulance service of the 5th battalion of the 1st Silesian Jagers, and had been in the field of war on the Prussian side since August 26th. He wrote to us on December 20th from Ville d'Avry. His division was particularly concerned with the investment of Fort Valerian, esteemed by the French as the strongest point in their defences. Our correspondent wrote to us compelled by a humanitarian spirit. He believed that humanity would be best served in the end by a speedy success at Fort Valerian and by the bombardment of Paris. With their strongest point gone, and living under the constant dread of falling projectiles, the French, he argued, would speedily capitulate. The trouble was, however, the the Prussians did not possess the artillery requisite to demolish the fort or to drop projectiles into the city from the distance at which they lay from it. Dr. Scoffern proposed to effect the same end by means of rockets. Against the fort he would send rockets containing a charge of phosphorus and iodine, separated by a diaphragm. These two bodies burning together would, he said, produce a gas of great density and extremely irritating to the eyes. When the fort had been blanketed in this manner, he would discharge against it rockets carrying a head of nitro-glycerine. For the bombardment of Paris at a range of 5 miles he proposed to use a large rocket headed by a smaller rocket, which, in turn, would be headed with nitro-gylcerine. In addition to the "humanitarian" argument advanced by the worthy doctor in favour of these means of bringing Paris to submission, he extolled as a virtue the fact that while the Prussians might use them against the French, the French could not use them against the Prussians. We do not know whether among the various gases used in the Great War the particular compound proposed by our correspondent was employed. It is certainly not the same thing as that known as "mustard gas" nor is it "phosgene."

REDUCING MINING COSTS.

AT length the Government and the people of South Africa are becoming alarmed at the dwindling life of the gold mines of the Transvaal, though it has taken a long time. The ex-Government Mining Engineer, Sir Robert Kotzee, a few years back, gave detailed information as to the time when the gold mining industry would reach its peak, and the various stages in its decreasing production up to the date when it would cease. Other mining experts added their warnings, and, finally, the present Government Mining Engineer, Mr. Hans Pirow, has recently given a complete review of the mines, based on the very latest data. Though this has taken a long time and has meant that many millions of tons of ore just outside the zone of payability, with working costs at the present level, are now lost, yet it seems that at last the country has come to see clearly that the most resolute and persistent efforts must be made to prolong the life of the gold mines by the reduction of working costs, so that huge tonnages of low-grade ore, at present unprofitable to exploit, shall be made to yield up their gold content to augment the supplies of the metal. For if the life of the Transvaal gold field is not prolonged until other gold fields, or minerals, have been discovered and brought into production, then the position of the Union of South Africa will be not far short of being one of bankruptcy. The value of the gold which is exported annually from the Union is about £44,000,000, and even with that the country is barely balancing its trade budget; in fact, when the invisible imports are taken into account, such as interest on loans, &c., there is an annual deficit, at least for most years. At present the national debt is £244,000,000, and, in addition, there is the debt on the large railway borrowings, also the loans obtained by municipalities. The necessity for reducing the working costs is emphasised by the fact that, as a corollary, not only will an amount of low-grade ore, estimated by some as amounting to 1,000,000,000 tons, be brought into the pay zone, but the profits won on ore of higher grade will be proportionately increased and the circumstances become more propitious for starting new mines. It is, of course, for the purpose of finding ways of reducing the working costs on the gold mines that the Low Grade Mines Commission has been appointed, and the Cost of Living Inquiry, which is being held, may be regarded as a complementary effort towards the same end. The heads of the mining industry do not think that a sufficient reduction in mining costs can be secured fully to achieve the object in view without a wage reduction, and the President of the Transvaal Chamber of Mines, giving evidence before the Low Grade Mines Commission, strongly pressed the necessity for a 5 per cent. reduction in European wages. It is, of course, impossible to ascertain how the Commission regards the suggestion, and much will no doubt depend upon the report of the Cost of Living Inquiry, and whether it supports the President's statement that the cost of living has dropped to such an extent that even with the reduction of 5 per cent. in the wages the worker will have more spending power than a year or two ago.

AN order for the construction of an all-welded steel Diesel-electric oil tanker, the first of its kind to be built in the United States, has just been placed with the Sun Shipbuilding Company by the Atlantic Refining Company. The Atlantic Company already has twelve tankers of the same type in use, but this vessel will be the first to be built without the use of rivets. It will be 200ft. long, 34ft. wide, and 12ft. deep.

The Chantarella-Corviglia Cable Railway at St. Moritz.

No. II. (*Conclusion*).*

IN our last issue we gave a description of the design and layout of the new cable railway which has been built by Theodore Bell and Co., of Kriens-Lucerne, to connect Chantarella with the Corviglia plateau above St. Moritz. We continue below our account of the mechanical and electrical equipment.

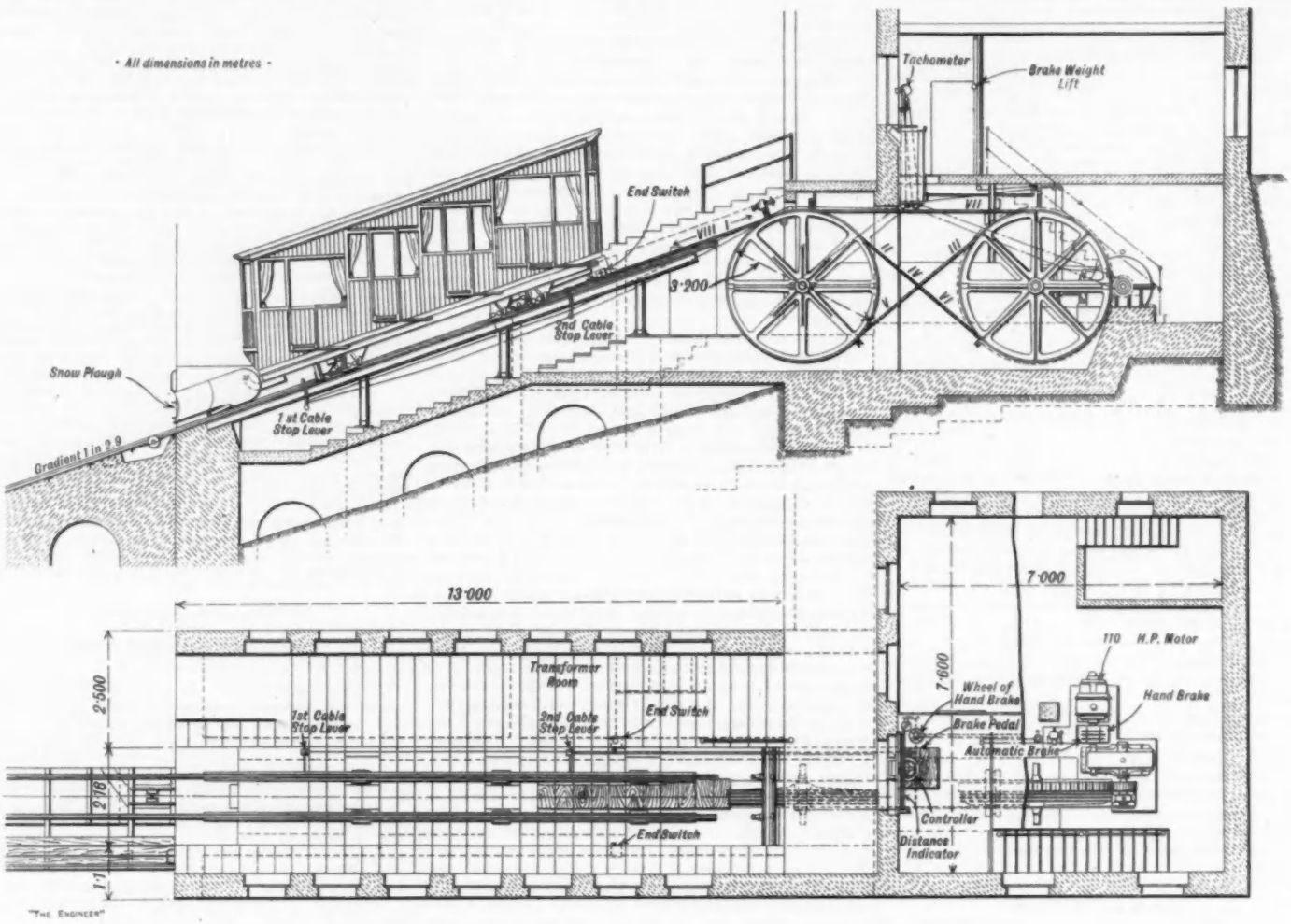


FIG. 7—ARRANGEMENT OF MAIN HAULAGE GEAR AT CORVIGLIA STATION

THE MAIN HAULAGE GEAR.

As will be seen from the accompanying drawing, Fig. 7, the main haulage gear is accommodated in the basement of the upper station near the Corviglia Hut, an outside view of which was reproduced in Fig. 6, *ante*. The electrical equipment, which was supplied by the Maschinenfabrik Oerlikon, comprises a three-phase, 50-period motor with a designed output of 110 H.P. at 970 revolutions per minute, and a maximum output of 120 H.P. Between the motor and the reduction gearing, which is enclosed, there is a flexible coupling embodying in its design a hand-operated and an automatic brake. The latter is set in operation by a centrifugal safety device, which comes into action if the normal speed of the cable is exceeded by about 20 per cent. The reduction gear is of the totally enclosed type, running in oil, and a pinion on the end of the shaft meshes with the driving wheel for the cable, which is in two parts and is furnished with a toothed rim alongside that part of the pulley carrying the three-cable grooves. Parallel with the driving wheel, there is a guide pulley with three grooves, alongside of which is a single pulley revolving on the shaft. The directions of the various ropes are indicated clearly by the Roman numerals I. to VIII. on the upper part of Fig. 7. The pulleys have a diameter of 3·2 m. Power is taken from the supply network at a pressure of 4200 volts, the supply being three-phase at 50 cycles. It is transmitted to the top station by armoured cables laid in a trough at the side of the permament way, and at the upper station there are transformers which reduce the pressure to 380 volts. The controls are so arranged that they can be worked from the operator's platform at the upper station. For starting and stopping, there is a thirteen-notch controller, and during the trip the speed of the car is kept practically constant by the asynchronous motor, which is designed on the regenerative braking principle. Other electrical equipment includes the control resistances, an ammeter, a voltmeter and an automatic switch with no load, overload and time limit releases. A small rectifier is used to provide charging current for the car-lighting batteries.

In the inspection pit below the car, there are arranged two cable stop-levers, which operate the limit switches and release the automatic brake at the motor coupling, thus preventing the car from going too far into the terminal stations. An additional provision is an end switch which accomplishes the same object by de-energising a magnet on the automatic brake gear controller. For normal working,

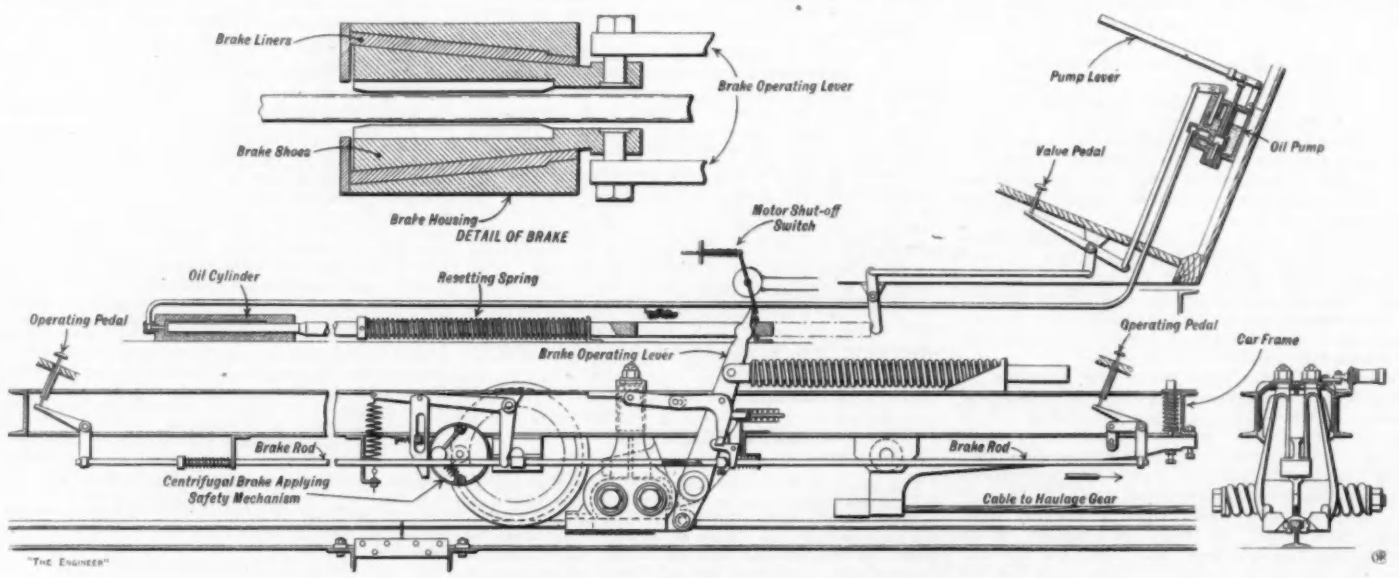


FIG. 8—ARRANGEMENT OF AUTOMATIC BRAKE EQUIPMENT

* No. I. appeared December 19th.

only the hand-brake, the wheel of which is shown on the control platform, is used. Other auxiliary devices for the control of the railway include a tachometer and a distance indicator. Both the stations and the passenger cars are equipped with telephone and signal arrangements, the telephone lines being carried on channel section masts at the side of the line. The distance indicator referred to, works on the contact principle, and shows the exact position of either car on the line. Care was taken so to build the stations that their appearance fits in with the immediate surroundings, and in both stations all the usual facilities are provided, including residential quarters for the staff.

AUTOMATIC CAR-BRAKING ARRANGEMENTS.

In Fig. 8 we show the mechanical arrangements for putting into operation and resetting the three automatic brakes, one of which is shown in the drawing. The drawing indicates the position of the brake in relation to the rail-head it embraces, and an enlarged horizontal section is also shown which explains the gripping action of the brake-shoes. As will be seen from the drawing, the haulage cable is attached to the lower and shorter end of a bell-crank lever, which is pivoted on the frame of the car and has at the end of the long arm a stiff compression spring. It is connected with the brake-rod through link gear. This rod is also controlled by a pedal at either end of the car. Should the cable break or suddenly lose its tension, the pull on the short end of the bell-crank lever ceases, and the vertical spring depresses the long arm moving the brake rod in the direction shown by the arrow. The small movement thus brought about releases the trip gear and toggle lever in the brake housing, and by the action of the powerful horizontal spring at the upper end of the brake-operating lever, the wedge-shaped brake-shoes are drawn together, and grip the head of the rail in the manner indicated in the sectional view to the right of Fig. 8. A similar application of the brake can be effected by the geared centrifugal safety mechanism which is shown on our drawing, and which is designed to operate when the speed of the car exceeds by 40 per cent. the maximum designed speed.

For railways with contact type current supply, a special motor shut-off switch is also provided, the purpose of which is to break the electrical connections as soon as the automatic brakes are applied. In order to release the brakes, there is a hand-cperated oil pump having a pedal-controlled valve, which is shown at the base of the conductor's platform. By closing the by-pass valve and working the pump oil pressure is applied to the ram, shown to the left of Fig. 8, which returns the brake-operating lever and trip gear to its original position. When in that position, the horizontal re-setting spring brings back the re-setting lever to its normal position.

With regard to the housings of the automatic brakes, attention may be called to the pair of heavy compression springs which hold the cheeks together, and the vertically arranged bolts attaching the cheeks to the frame, which prevent any tendency of the car to lift when the brakes are applied. The design of the brake-shoes is such that the inner linings can be easily renewed while the outer bronze brake-liners prevent any jamming so that the braking is both smooth and quick, no matter what the condition of the rails. The manner in which the brake housing is suspended from the frame enables the shoes to be set in their normal running position at a distance of only 2·5 mm. to 3 mm. from the rail-head. Such a close position allows braking to take place equally well on straight runs, bends, or sharp curves. The smooth running of the cars and the good braking is greatly assisted by the makers' special design of fishplates and intermediate plates for the rails, one of which is shown in the lower part of Fig. 8. They are of a very strong type, and surround the lower part of the rail, while leaving the head of the rail free for the brakeshoes. Any inequality in the upper surface of the rails at the joints which might give rise to knocking is thus prevented.

The hand brake, which is fitted in addition to the three automatic brakes, is applied by a hand wheel and only three to six turns are required to bring the car to rest. Hand braking is only used when it is necessary to keep the car standing over a long period or when carrying out brake trials and is not employed during the course of ordinary working.

A few particulars with regard to the official brake trials may be of interest. They were made on December 13th and 14th, 1928, during a spell of intense cold and snow. The fully loaded car was tested on the maximum gradient of 1 in 2·2, and after running back 1·26 m., in order to attain the maximum speed of 3·2 m. per second, the brakes were applied by releasing the car from the cable; it came to rest in a length of 552 mm. after the point at which the brakes were applied. When a car was at rest or ascending the mountain, the movement backward when the car was released from the cable only amounted to 20 mm. to 30 mm. before the car was brought to a standstill. At the designed maximum speed of 3·2 m. per second, the brakes acted in the short distance of 215 mm., which corresponds to one-fifteenth of a second.

When, at the beginning of the 1929 summer season on June 13th of that year, the official brake trials were again carried out, the complete programme was gone through without having to make any renewals or adjustments to the brake-shoes, and the geared centrifugal safety attachment operated immediately a speed of 4·7 m. per second was reached.

In order to enable the railway to be worked under extremely snowy conditions, a special snow plough has been designed, a view of which is shown in Fig. 9. It is arranged to push the snow off the track in the direction of the valley, and it is attached to the car by links which enable it to be raised when the car is ascending. It only weighs 120 kilos., and it has been thoroughly satisfactory in action.

CONSTRUCTION AND RUNNING RESULTS.

The general contractors for the railway we have described were Theodore Bell and Co., Kriens-Lucerne, which firm also built the St. Moritz-Chantarella Railway referred to in our last article. The contract for the Corviglia Railway was placed in June, 1928, and work upon the line was immediately begun. On December 11th of the same year, the first cable was drawn through, so that after official tests two to three days later, the railway could, after a few instructional runs, begin its service on December 18th, or two weeks before the time stipulated in the contract. The railway has continued to operate throughout the recent winter and summer seasons without interruption. The two main periods of

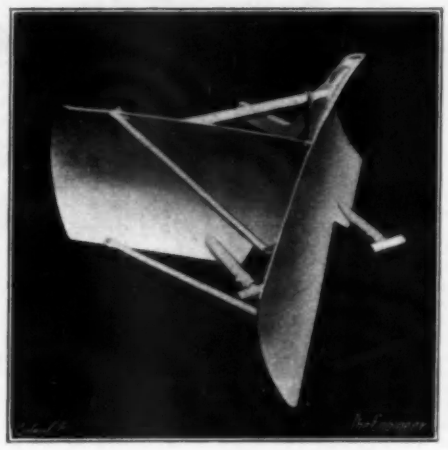


FIG. 9—SNOW PLOUGH

working are from June 15th to September 30th, and from December 1st to March 31st. The number of double runs per day is forty-four, which correspond to over 70 kiloms. for each car. The average cost of current during the first winter season worked out at 0·64 Swiss franc per double journey, while the capital cost of the undertaking was 880,000f., or about £35,200. The railway staff includes an engineer, two car conductors, as well as an inspector of permanent way and station *personnel* according to the traffic. The working of the railway during busy periods has shown that the maximum capacity of sixty persons for each car can be safely used.

CONCLUSION.

The railway, has in practice, been found to satisfy fully the purposes for which it was designed, and it marks a further notable addition to the eighty mountain and special railways at work in Switzerland.

The initiators of the scheme, the contractors, and the civil engineer, Mr. H. H. Peter, to whose design and under whose supervision the scheme was carried out, deserve congratulation on the decided success which has attended their work. With regard to Mr. H. H. Peter's formula given in our last article, the factors Tα and p should be reversed so as to read Tα maximum cable pull, and p the weight of the cable per metre run.

Old Cornish Mining Terms.

AT a meeting of the Newcomen Society on December 17th, with the new President, Mr. Greener, in the chair, Mr. Arthur Titley, Past-President, presented an interesting review of books in which Richard Trevithick—"Capt. Dick"—had entered notes about mining ventures with which he was connected as Mines Manager and "Lord's Agent" in the Bassett interest.

There are four books as follows :—

1. Marked : "*Smelt'g House Acc't Book.*"

"Dolcoath Deep Adit Account" from Sept : 1765 to Sept : 1767.

"The New Dolcoath Account", Oct : and Nov : 1767.

Both these refer to the construction of the deep adit made at Dolcoath under the management of Trevithick Senior. "Furnace Cost" from Dec : 1771—*i.e.*, the year in which Richard Trevithick Junior, was born—to October 1773. "New Engine Cost" 1775. One page of this book gives "Ores and Cost of Smelting at ye Furnaces :, for July, Aug : and Sept : 1772,"; the name of the mine is not given.

This book was afterwards used by Richard Trevithick as a ledger, and contains much matter to which, unfortunately, there are few clues. It also has "Wheal Francis Cost" from May to Dec : 1813. This was a small mine worked by Trevithick himself in the midst of his activities during the three years prior to his departure for Peru in 1816.

2. Marked : "*Eastern Stray Park Cost Book March* 1790" contains the Cost of the mine from that date to June 1792. It was used by Trevithick as a draft letter-book, from March 1812 to Sept : 1813.

3. Marked : $\frac{\text{"3"}}{\text{R}}$ has "*Wheal Treasury Cost*" from March 1795 to Dec : 1797 when the mine was closed.

The remaider of the book was used by Trevithick as a draft letter-book from Sept : 1813 to Oct : 1816 when he sailed for Peru. It has also a few drafts of letters by others bearing on his life in South America.

4. Marked : "ON," contains a very complete list of copper ores sold by eighty-six Cornish mines from Jan : 1777 to Jan : 1779.

The remainder of the book was used by Trevithick, partly as a ledger and partly as a rough cash-book or rather memorandum-book of transactions. They present the same exasperating lack of clues as do the rest of his accounts.

Before considering these old mine accounts, Mr. Titley gave a brief description of the method by which the Cornish mines were managed. The description is full of philological lore, which cannot fail to interest many of our readers. This section of the paper is printed below.

The system of working by "Cost-book," although still legal under Stannary Law, dropped out of use about twenty years ago. Under this system all expenditure was charged to revenue account. If a new mine was to be opened, a "sett" having been granted by the "lord" or owner of the land, a minimum of six shareholders, or "adventurers," could, under Stannary Law, form a Cost-book Company. A meeting was held at which were passed the necessary resolutions pointing out the objects for which the company was to be formed, and these were entered in the Cost-book. A committee of management—without pay—was appointed, as well as a manager, purser, and engineer, whose pay was stated, and the manager was authorised to carry out certain work and spend a stated amount of money. The Cost-book was then signed by the Adventurers present, and each wrote after his name the share he was prepared to take up. The appointment of a date for the next meeting terminated the proceedings. The purser, who was the business official of the mine, then took the Cost-book to the Bank, and if the Bank was satisfied with the names of the Adventurers, it agreed to honour cheques drawn by the purser to discharge the debts of the Company as they occurred up to the amount recorded in the Cost-book. At the end of the agreed period a second meeting was held, when the purser produced the Cost-book with all wages, goods bought, dues (royalties), rates, and other outgoings, entered in it, at the end of which a balance sheet was written up and the amount due to the Bank shown. By a resolution of the meeting a "call" was made of so much per share to discharge the debt due to the Bank. Any further resolutions for the future conduct of the Company were then passed and entered in the Cost-book which was again signed by the Adventurers present. Other books were added as the business developed, but all those containing information required under Stannary Law were regarded as part of the Cost-book. The system had this advantage for a highly speculative business, that the position of the Company could at once be seen at short intervals. Its disadvantages are equally obvious. Adventurers who did not attend meetings were bound by the resolutions passed by those who did. If they did not agree they could relinquish their shares, but were still liable for the debts incurred till the next meeting. There was always the temptation to carry forward liabilities till some creditor threw the Company into the Stannary Court, which would make a call upon the Adventurers whose liability was jointly and severally, so that if any could not pay the liability fell back upon the rest. The period between meetings appears to have been in the eighteenth century usually two months. Later it was considerably lengthened, and forty years ago had increased to sixteen weeks. Seven Adventurers were required under Stannary Law to wind up a Cost-book Company. In rare instances, as at Wheal Virgin, it was not necessary to make a first call. In this case an early discovery of rich copper ore enabled the mine to carry on till the dividend stage was reached, the outlay on dressing plant being much less in the case of copper than in that of tin. Copper ore after hand picking often only required crushing and sizing or "jigging" to render it fit for the smelter, and the crushing rolls were often driven by a whim engine during intervals of winding.

The labour on the mines was divided under many heads. Under the manager or chief "captain," underground and "grass" captains superintended the various operations, these being recruited from the ranks of the men trained on the mines. Besides unskilled labour handling ores and "deads" or "attal"—as the waste rock, &c., is called—there were pit and shaft men about the pumps, engine and firemen, kibbal landers, whim drivers, burning-house men, binders, carpenters, masons, and smiths, as well as surface workers dressing ores—many of these being women called "bal-maidens"—who were paid day or piece wages, according to the work they did.

The real miners were divided into two classes—"tut-workers" and "tributers." Tut-workers were those who sank shafts and drove levels and cross-cuts, and were expert in the general work of excavation underground. They were usually paid by contract at so much per fathom, the work being measured to an inch. The cost of tools and materials used in their work was deducted from their pay.

The tributers were the most highly skilled of all. They worked out the actual ore, engaging to work a certain area in the mine called a "pitch," taking for payment a proportion of the value of dressed ore actually realised on sale. For example, if the realised price of a particular parcel of ore was £20, and the tributer had agreed to work the pitch for 13s. 4d. in the pound, from the tributer's portion of £13 6s. 8d. the cost of dressing the ore was deducted and he received the balance. The rate at which he was paid was arrived at by a kind of auction, the various pitches being competed for by the tributers on the

periodical settling days. The chief captain acted as auctioneer, standing with a handful of pebbles in his hand. The clerk read out a description of the various pitches for which the men bid against each other. They worked in gangs of two or more, called a "pare," each pare choosing one of its number to act as its spokesman to bid for it. When the bidding slackened the captain threw a pebble up in the air, and if it reached the ground before another bid was made, the pitch was "sett" to the pare who made the last bid. As there was, of course, considerable delay from the time the ore was raised till it was dressed and sold, it was customary for the tributer to receive an advance or "subsist." Under this system the tributer became a specialised geologist, depending for his success on his knowledge of ores and his capacity to judge their probable yield. His interest generally was that of the Adventurers, that of raising the greatest quantity of the richest ores, although the system sometimes led to dishonest practices on the part of the miner, such as those working poor pitches robbing the ore heaps of those more lucky, or two pares, one working rich and the other poor pitches, combining to average the quality and so get a better price, the poorer ores being paid for at a higher rate per pound realised.

Work underground was usually carried on day and night in eight-hour shifts, or, in miner's language, "cores." A pare of men, say, nine, working at such jobs as shaft sinking, would work three in a core. The "fore-noon core" began at 6 a.m. and went on till 2 p.m. The "afternoon core" then came on and worked till 10 p.m. when the "night core" began and worked till 6 a.m. Each period of eight hours ranked as a "stem" to each man, and this term is found in the old accounts as representing generally a day's work of eight hours. In the old days the forenoon core worked six stems weekly, the afternoon and night cores only five stems. A change of shift was made each week, so that the forenoon core of the last week became the night core of the current week, and so fairly divided the day and night work among the men.

Another term to be found in the old accounts is "spale." This was a fine—I believe, illegally enforced—to maintain discipline among the miners. For instance, if a miner coming to "grass," put his head above the curb of the shaft before the whistle or bell sounded, and was seen by one of the captains, he was spaled or fined, and so on for other breaches of the mine regulations. The amount was usually the sum paid for a stem or eight hours' work. The money collected in spales appears to have been variously applied in different mines, but later in those which were best conducted it was handed over to the miners' hospitals or nursing associations.

We also find as far back as 1765 a deduction from wages of 2d. per month for "doctor's column" for medical service, and it was also common to deduct a further 2d. for the barber who attended the mine to give the men their periodical shave and clean-up. In some mines it is said that this caused trouble, as the youths employed objected to contribute to the shaving of their elders, when they had not yet arrived at the condition needing the same attention themselves. Previous to 1887 wages were paid per calendar month, but pay day was on a Saturday, so that in each quarter there were two four-week months and one five-week month. As a month's wages was kept in hand for alleged convenience in making up the accounts, a man might work for nine weeks before he received any wage.

In the succeeding part of the paper Mr. Titley managed to extract a remarkable amount of illuminating information from the four old books already mentioned, and gave the meanings of several of the unfamiliar terms.

We extract a few sentences in which such definitions appear:—

"To Geo. Paddy for a Ball suit as by bill £1 . 2 . 0." "Bal" is the general name for a mine, referring specially to the ground-level working. Then we have "Thos. Bawden, binder," who was paid 40s. per month, and who later on was severely spaled 5 stems at 18d. Binders attended to the general underground timbering of the mine. The price paid for sinking shafts and driving levels varied from £1 2s. 6d. to £4 per fathom, and the work was measured in fathoms, feet, and inches. Then we have "for Cutting a Barrow Road and putting in a Sollar in the Shaft." a sollar being a timber platform with a trap-door by which the miner passes from the foot of one ladder to the head of the next below. I remember an old miner at Botallack Mine describing how he had to climb vertically for nearly half an hour till he arrived at the top of the shaft before his walk home after his arduous day's work.

Then we find "to Midsummer to three men 3/-." This was a gratuity paid on the occasion of a holiday, a custom formerly common in Cornwall. We have also the "Doctor's Culm" (Column), and one learns that John Davy received 30s. per month for keeping the Book.

"Richard Rabling 1 stem loading the plow and helping home the Plumps 1/-." The plough or plow is probably a sledge for transport over rough ground. Plumps were pumps, a term still to be heard in Devon and Cornwall.

Ann Heather was paid for "Bucking 319 Barrows of Calcined work at 6d. for every 15 Barrows 10/7." "Buck ing" was breaking by hand by means of a hammer.

"William Harry for 13000 pins for ye Healing 6/6." Healing or helling is tiling or slating, a term still used outside Cornwall. The stone tiles and slates have holes knocked in them with a pin hammer, into which the pins are driven and by their means the tile is hung upon the laths, the underside of the roof being sometimes plastered over to hold the tiles in their places. The split stone tiles used in Herefordshire and the Cotswolds are put on in the same way. "To Silvester James for 30 ft. of Crease at 3½d. 6/3." Crease is crest or ridge tiling.

Thomas Rodds for "Sundry Carriage with his Werry." The Oxford Dictionary describes a Wherry as a four-wheeled cart without sides and gives a reference to the present use of the work in Yorkshire. John Davy was paid for "Putting in a Pentice and hanging a Wins." A pentice or pent-house is a structure of timber to protect the workers in sinking a shaft. A win is, of course, a winch. In the old days winding was done by means of a chain or hemp rope. One of the commonest events in a mine was the breaking of these, when a kibbal, weighing perhaps 5 cwt. and 50 fathoms or so of chain, fell crashing down the shaft. In order to avoid damage to the ladderways and pump work winding was often done in a separate shaft. When sinking a shaft, a "pentice" was built near the bottom, of heavy timbers with a sloping roof. On this, other timbers were placed, and upon them two or three fathoms of waste rock, &c., a small opening being left for raising the excavated material by hand high enough to be wheeled along a level to the whim shaft and to be conveyed to the surface. The pump work also passed through the pentice. In this way the shaft was deepened 10 or 12 fathoms, and this was known as a "Sink." The pentice was then rebuilt at the lower level and the process repeated.

Electrical Control Gear.

THE heavy control gear shown in Fig. 1 is one of the equipments which have been made by Laurence, Scott and Electromotors, Ltd., for machines intended for balancing large turbine rotors weighing 17 tons or more. Control gear of this type has been supplied to Royal dockyards and to several private shipyards, the actual equipment illustrated being rated at 750 H.P. at 440 volts D.C. The motor controlled by these equipments is a more or less normal machine, but it has to stand very heavy starting torque, corresponding to about double the rated load. A wide range of speed may possibly be required, and to deal with the maximum speeds, without intervention of gear, it is generally necessary to design the armature to stand a higher speed than normal for the size of machine.

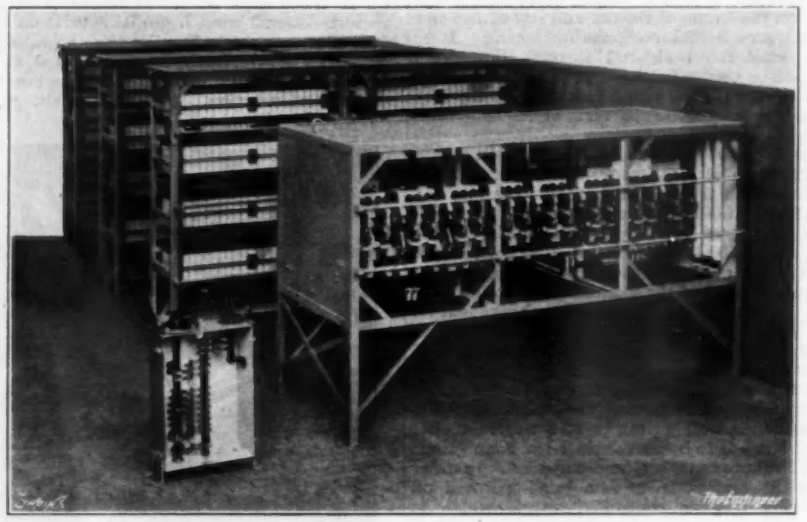


FIG. 1—CONTROL GEAR FOR BALANCING MACHINE

The control gear is much more special on account of its exceptional heavy duty, both as regards starting torque and frequency of operation. The progress of balancing is to accelerate the rotor under test as rapidly as possible to something over the speed which it is intended to use for the readings, then to unclutch the motor, and get the readings while the rotor is slowing down. As soon as the set of readings has been taken, the clutch is re-engaged, and both the rotor and the armature of the motor are brought to rest without loss of time, thus preparing for the next set of readings. It should be possible to run up and through the complete cycle to rest again, make adjustments, and to be ready to restart some 15 to 25 times per hour, according to the size of the job being balanced. As the rotor alone frequently takes 20 minutes to come to rest, the dynamic braking which is adopted serves an essential purpose. The operator works entirely on the small master controller, to be seen in the illustration—Fig. 1—over the connections from motoring to braking. The single-pole contactors which cut out main resistance are arranged in the same straight lines and also back to back. The contactors are provided with two sets of devices to ensure that they close in rotation and with suitable delay. After a predetermined delay, one set of mechanical delayed timing devices makes the operating circuit of the next contactor, and thus determines the maximum rate of acceleration under any circumstances. Another set of current lock-out devices still further increases this delay according to the inertia of the rotor. The same devices come into play when starting up the motor or braking. The operation is therefore foolproof, and although the man in charge can if he desires move the handle step by step as slowly as he wishes, no harm is done if he throws his switch right over to full on or right round from full on to braking.

FIG. 2—CAM-OPERATED CONTROLLER

The resistances, which are rated for practically continuous running, consist of punched steel grids treated with a rust preventing process and insulated entirely with mica. The whole of the gear, resistances, controller and master, is built up on the metal and mica principle, with no back connections, all the heavy bare copper connections and fine wire wiring being visible in the front where they can be readily traced. The controller illustrated is interesting by reason of the fact that it is unusually

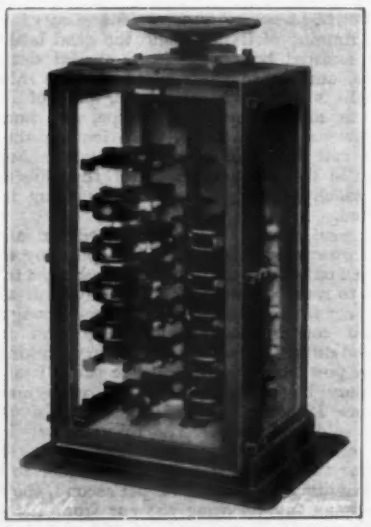


FIG. 3—CONTROLLER WITH COVER REMOVED

The operation is therefore foolproof, and although the man in charge can if he desires move the handle step by step as slowly as he wishes, no harm is done if he throws his switch right over to full on or right round from full on to braking.

The resistances, which are rated for practically continuous running, consist of punched steel grids treated with a rust preventing process and insulated entirely with mica. The whole of the gear, resistances, controller and master, is built up on the metal and mica principle, with no back connections, all the heavy bare copper connections and fine wire wiring being visible in the front where they can be readily traced. The controller illustrated is interesting by reason of the fact that it is unusually

large for D.C., and because of the starting and braking conditions required.

At the Norwich Works, Laurence, Scott and Electromotors, Ltd., manufacture a considerable range of high-grade D.C. and A.C. control gear, which is the result of over thirty years' experience in marine and other work. Even down to the smallest details, all the gear is constructed on the metal and mica principle, and complies with the Admiralty specification, including such drastic requirements as shock and vibration test and total immersion for water-tight gear. The illustrations, Figs. 2 and 3, show a new design of cam-operated windlass controller, suitable for controlling motors that are not large enough to

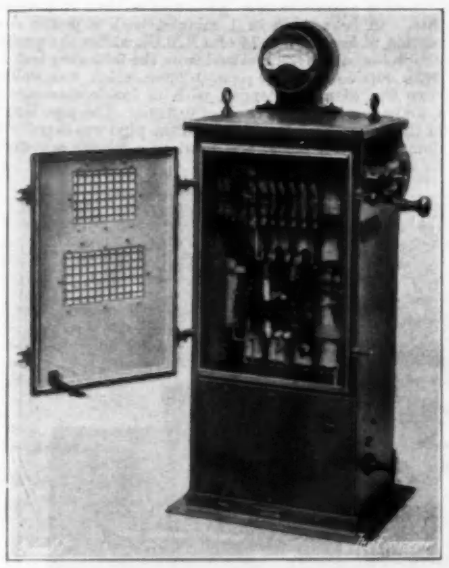
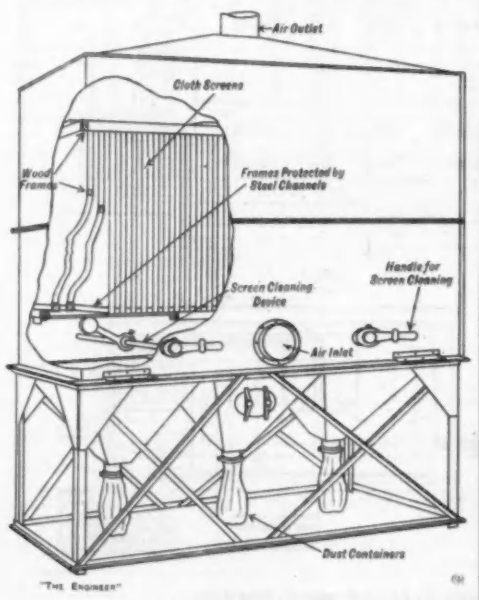


FIG. 4—MOTOR STARTING PILLAR

justify fitting a complete contactor controller and master. The cam-operated units are mechanically operated contactors, and each has its own blow-out and spark guards, the circuit being broken with a quick snap action. The maintenance is therefore very much less than on a barrel type controller; in fact, apart from the provision of automatic features, the operation is equal to that of a contactor controller. Fig. 4 shows a recent design of pillar starter for engine-room auxiliary machinery. A special feature is that there is no cast iron, slate, or other breakable material in the construction, and as all parts are accessible from the front, the pillar can be fixed close up against a bulkhead.

A New Dust Arrester.

A NEW type of dust arrester, which has been designed to meet the requirements of Section 79 of the Factory and Workshops Act, dealing with grinding and finishing processes, is now being put upon the market by Tilghman's Patent Sand Blast Company, Ltd., of Broadheath, near Manchester, which claims that it is very efficient. A sketch of the apparatus is appended, and from it it will be seen that



DUST ARRESTER

it is of simple construction, is entirely self-contained, and has no moving parts except one, which is used occasionally for shaking the dust off the screens. The apparatus comprises essentially a number of vertical rigid canvas screens mounted in a steel casing in such a manner that the incoming air cannot pass to the exhauster without being relieved of the suspended dust by the cloth screens, the dust being afterwards deposited into removable containers situated below the hoppers.

The casing is made with flanged joints, which are bolted together so that it can be easily dismantled for examination purposes. The filter cloth is glued on to frames of seasoned wood, reinforced by galvanised wires which impart a slight whipping motion to the cloth. One of the objections to this type of dust arrester in the past has been the clogging of the filtering medium by the dust, which offers resistance to the free flow of the air. Messrs. Tilghmans state that they have overcome that drawback in two ways. In the apparatus illustrated they employ hand-operated handles attached to transverse shafts on which are weighted levers for rapping the frame that carries the screens. If desired, this shaking operation can be performed by pneumatically-operated vibrators instead of by hand. For very large dust catchers the makers provide an alternative method for removing the dust from the screens, in which a system of blast-gates fixed in the connecting pipes brings about a reversal of the flow of air through the apparatus, which causes the dust to be blown back into the hoppers and bags. For this purpose no separate exhauster is necessary, the fan supplied with the apparatus being used.

We understand that 1 square foot of filter surface is sufficient for dealing with 2 cubic feet of air per minute, and that the pressure required is about 8in. on the water gauge. The smallest size of apparatus that is made is designed to deal with 700 cubic feet of air per minute, and it occupies a space of 10ft. by 3ft. 4in. by 3ft. The makers are at present constructing a plant for dealing with 16,000 cubic feet of air per minute, which is to be 24ft. long by 8ft. wide by 16ft. high. This apparatus will be operated by a motor-driven fan of 50 horse-power.

A 5-Ton Warehouse Truck.

WE recently had an opportunity of inspecting the warehouse truck, illustrated by the above engraving which is claimed to be the largest of its kind yet manufactured. It has been made by J. Collis and Sons, Ltd., of 43, Regent-square, King's Cross, London, for Messrs. Pickfords, and is to be used in handling furniture containers, such as that shown in the illustration, which may weigh up to 5 tons and measure 17ft. by 7ft. 6in. by 7ft. 6in. high. To this extent the contrivance is interesting, but it is especially so on account of the steering gear arrangement, which is, we believe, quote novel.

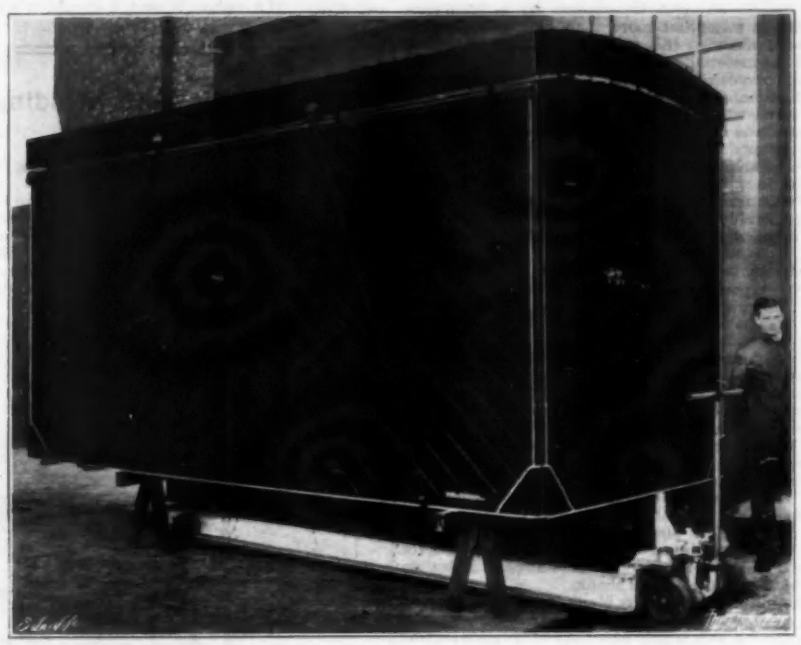
The standard Collis truck has a three-wheel arrangement, which makes steering a simple matter, as the single wheel is directly attached to the hauling handle, but it was considered that for such a large-sized machine as that under review, four wheels were necessary. It was also desired that the truck should be so easily manœuvrable that it would turn within its own length, and as a consequence a new system of steering gear was evolved by the makers.

The familiar Ackerman steering gear is, of course, a compromise, and serves very well for the ordinary turning of road vehicles, but in this case much more accentuated conditions had to be met, and the problem was solved in the following manner.

The two front wheels, which are plainly shown in the engraving, are mounted in forks in ball bearing brackets on the framing. On the vertical spindle of each wheel fork there is an excentric toothed wheel or pinion. Running across the front of the framing there is a toothed rack bar, which meshes with these pinions and also with another pinion fixed on the socket of the steering arm. The swinging of the steering arm moves the rack bar back and forth, and consequently rotates the pinions and steering wheels; but the relative rotation of the two carrying wheels depends upon the excentricity of the pinions, and the parts are so proportioned that as the wheels are turned their centre of rotation always remains within the centre of the back axle and the truck can consequently be turned within its own length with a minimum of effort.

5-TON WAREHOUSE TRUCK

J. COLLIS AND SONS, LTD., LONDON, ENGINEERS



The difficulty of meshing the transverse rack with the excentric pinions, throughout their rotation, is overcome by varying the height of the rack teeth to meet those of the pinions. In other words, the rack is cut on a steadily increasing gradient, instead of being straight. We asked the designer if this form was the result of trial and error, but he assured us that it was the direct result of drawing-office work, and it produced the desired result at the first attempt.

The general construction of the truck requires little comment, as it is of standard design. It embodies a main frame of channel iron, above which there is mounted a platform supported by toggle levers. These levers enable the platform to be lowered, so that it can be run underneath a load, and then, by means of a hydraulic pump, operated by the steering handle, and a ram, the load can be picked up off its supports, such as the trestles shown in the engraving, and taken away on the truck.

We have tried this truck in the maker's shop, and found it very handy and easy to manipulate.

Cemented Tungsten Carbide as Applied to Cutting Tools.*

By L. J. ST. CLAIR.

THE comparatively recent advent of cemented tungsten carbide into the field of cutting mediums is apt to convey the impression that this material has been known only a short time. However, such is not the case, as tungsten carbide has been known for more than forty years; but due to certain inherent physical weaknesses and the difficulty of using its extreme hardness to good advantage, little general interest in this material, as such, developed.

The economic pressures brought to bear on Germany with the coming of the World War, made it necessary for them to obtain or find an adequate substitute for diamonds in drawing tungsten wire for lamp filaments. As a result, Messrs. Baumhauer and Schroter, metallurgists at the Osram Lamp Works, Berlin—an affiliation of the General Electric Company—carried on certain experiments with tungsten carbide, and soon discovered that the essential properties of strength and toughness must be gained if this material was to become of commercial value. Further experimentation disclosed the fact that metallic cobalt could be utilised for this purpose. The combination of these two materials resulted in what we now speak of as cemented tungsten carbide.

Messrs. Schroter and Baumhauer first applied this material—cemented tungsten carbide—to wire drawing dies as a substitute for the diamonds they had found so difficult to obtain. The success of their experiments was proven by the fact that they got equal or better results. Their next step was the replacement of diamond tools for the machining of various bakelite compositions, which, as all know, presents certain machining difficulties in their extreme abrasive action on the edge of a cutting tool. Their success on this second application was the signal for considerable interest in this new material and its possibilities were quickly recognised by interested companies, who secured the rights to exploit further and apply the material.

The physical properties of cemented tungsten carbide are interesting, and give indications as to which of its characteristics may be taken advantage of or compensated for in its application to cutting tools for various materials.

(1) Its extreme hardness is perhaps the best-known quality. Measured on the Rockwell "A" scale, its hardness lies between 87 and 92. These figures are made more interesting by remembering that infinite hardness on this scale is designated 100.

(2) Its coefficient of expansion is only half of that of

* The American Society of Mechanical Engineers, December 1st to 5th, 1930. Abridged.

Invar steel, which has the lowest coefficient of expansion of any known metallic substance.

(3) Its electrical conductiviy is low. Cemented tungsten carbide is practically non-magnetic.

(4) Its compressive strength is greater than that of any known material.

(5) Its tensile strength determined by a transverse rupture test is somewhat more than half of high-speed or tool steel, although this value depends on the cobalt content of the material, as well as the treatment which the individual compositions receive throughout their preparation and manufacture.

(6) As expressed by Young's modulus of elasticity, its bending modulus is almost three times that of steel, and is the highest modulus of elasticity of any known material, coming well above tungsten.

As might be expected, the metallurgy of combining two powdered constituents to produce this metallic substance, differs considerably from the metallurgy of common practice and requires a new and different technique of procedure.

It has already been said that cemented tungsten carbide is made from powdered cobalt and powdered tungsten carbide. The two powders are mixed by ball milling and various tests have indicated that during this milling operation a coating of cobalt is formed around the extremely hard tungsten-carbide particles. It is for this reason that the grain size and milling time become such important factors in producing cemented tungsten carbide with the required properties of hardness and strength.

This new combination of powders is then pressed into shape on hydraulic presses, after which this pressed bar is fired to increase its cohesive strength to a point where the mass is workable and may be easily cut, shaped, or turned. The final step in the production of a cemented tungsten-carbide blank is the sintering, which is simply a firing process. The blank is placed in a hydrogen atmosphere, brought to a high temperature, which is maintained for the required length of time, and then removed. It is then ready to be attached to a tool shank.

A cemented tungsten-carbide blank is attached to a tool shank for several reasons, among which are—the economy of such a practice, as it is only necessary to obtain a cutting edge, and, secondly, as has been already pointed out, the physical characteristics of this material have indicated that this is the logical way to utilise this material to its best advantage.

Due to the tendency of the cobalt to combine with oxygen, considerable experimentation had to be carried on before the present method of brazing the cemented tungsten-carbide blank to the tool shank with copper in a hydrogen atmosphere was perfected. Tests were made of attaching the cemented tungsten-carbide tip mechanically and by welding, but these were discarded in favour of the copper braze, which is the practice generally followed to-day.

Knowing something of the physical properties of cemented tungsten-carbide, and having some appreciation of its economic value as a cutting medium the next query is—What are the factors that lead to its successful application? These are:—

(1) Design of a cemented tungsten-carbide tool.
(2) The machine tool.
(3) Care of the tool in operation.
(4) Grinding.

Tool design is fundamentally a question of getting sufficient support for the cemented tungsten-carbide tip, and, at the same time, allowing for the proper clearance angles. Generally speaking, the tip should be sufficiently large to withstand any strain placed on it, and the shank should be designed to have the greatest top-to-bottom dimension possible, so as adequately to support the cemented tungsten-carbide tip. Because of the vast difference in the physical properties of cemented tungsten-carbide, as compared to high-speed and other tool steels, the maintenance of minimum clearance angles is very important. In general practice, a front angle of 6 deg. or less, depending on the diameter of the work, has been found to work to the best advantage.

As has been pointed out, one of the characteristics of cemented tungsten-carbide, that tended to retard its commercial usefulness, is the fact that it will not bend or deflect without breaking. In applying a cemented tungsten-carbide tool on any machine, this characteristic must be kept well in mind and the general condition of the machine critically studied before the tool is run. First of all, the tool set up should be as rigid as possible. The machine should be in good mechanical condition and any looseness that might produce vibration or chatter be eliminated. This is important, as any chatter or vibration will be found particularly detrimental in the successful life of a cemented tungsten-carbide tool.

It is well not to attempt to run a machine at the highest speed possible, despite the fact that one of the primary advantages when using cemented tungsten-carbide is increased machine speed right from the start. It is better to start at a lower machine speed and accelerate it gradually, as in this way it will be easier to discover the critical speed at which the cemented tungsten-carbide tool should be run on that particular application. Following such a routine will eliminate a lot of grief.

Grinding a cemented tungsten-carbide tool is a simple matter that enters very largely into the efficiency of tools tipped with this material.

(*a*) The grinding machine used must be free from vibration.

(*b*) Both hand grinding and machine grinding can be used with satisfactory results, though machine grinding is preferable, since the proper angles can be held more accurately. When hand grinding the following should be considered:—(1) The use of rest and angle fixtures on pedestal type grinders is strongly recommended. (2) The tool should be constantly in motion back and forth. This minimises glazing and keeps the wheel true.

(*c*) When grinding a cemented tungsten-carbide tool in an automatic machine, such as a surface grinder, the down feed should not exceed 0·003in. in any case.

(*d*) The proper type of wheel to be used depends on the grade of the cemented tungsten-carbide, the stock to be removed, and the finish required.

Best wheel performance will probably be obtained at about 5000ft. surface speed per minute.

The tool should not be forced against the wheel, but light pressures used, and the tool moved transversely across the cutting face of the wheel.

The wheel should be dressed frequently to prevent glazing. A glazed wheel causes local overheating and checks the cemented tungsten-carbide. It can be ground wet or dry. If a coolant is used, it should be a heavy flow.

Resistance Butt Welding in Shipyards.

THE application of resistance butt welding in the shipbuilding industry has recently met with considerable success, and another field has been opened up to this ever-progressive method of uniting component parts which go to make up a complete structure. At the works of Alex. Stephen and Sons, Ltd., of Linthouse, Glasgow, we recently inspected a heavy-duty butt welder, developed by the A-1 Electric Welding Appliance Company, of 64, Victoria-street, S.W. 1, capable of welding tubes up to 6¼in. external diameter and of 8 square inches sectional area. The machine, which is shown in Figs. 1 and 2, is of the hydraulically operated automatic type, and has been designed for welding together steel tubes, and tubes to flanges, the results obtained showing substantial savings to the shipbuilder. The old and costly method of screwing the pipe and flange and afterwards expanding, caulking, or welding the joint, has now given place to the new method, which can be quickly carried out with a minimum cost of labour and heat energy. The process, we are told, shows very marked advantages over all other methods, and particularly in the case of large shipbuilding companies, which have to unite steel flanges to a large number of steel pipes of various diameters, shapes and lengths.

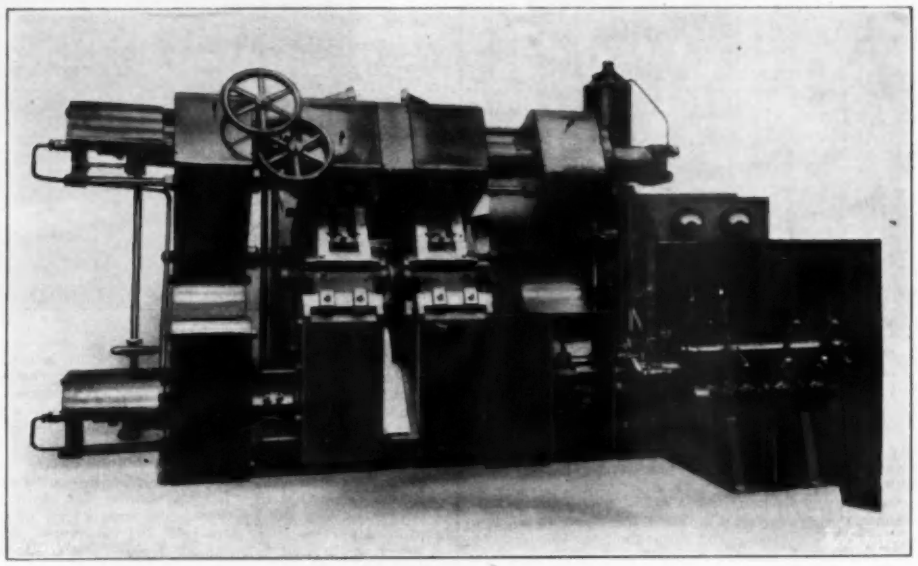


FIG. 1—ELECTRIC BUTT-WELDER FOR TUBES

Engineers with shipyard knowledge and experience will probably agree that the plumber's department in every shipyard has been the most backward, and that comparatively little progress has been made in speeding up work by the use of up-to-date mechanical and scientific methods.

One of the chief advantages of butt welding, when applied to the class of work mentioned, is that it expedites the work and enables shipbuilders to accept contracts involving quick delivery.

When the pipe and flange to be welded have been clamped in the machine, the welding is done automatically, and once the machine has been adjusted for any particular job any number of welds may be made at will, and all have the same consistent and reliable quality, these results being obtained by reason of the fact that the mechanism of the machine automatically controls the three primary factors essential to a reliable weld. Some idea of the saving in time and costs can be gathered from the fact that a steel tube 6in. in diameter and with a wall thickness of approximately ⅛in., and an area of 6 square inches, can be welded in 1 minute, with a power consumption of less than 0·75 of a B.T.U., whilst the quality of the welds can be appreciated from the following test:—A 2½in. outside diameter pipe, 0·200in. thick, was welded to two 6in. diameter flanges, with an inside diameter of 2in. and an average thickness of 0·219in. The pipe length over the flanges was 4ft. 0½in., and the pipe was fitted with a flange and tail piece, and used as a tensile specimen. At a total pull of 28·84 tons, the bolts gave way, and on supplying new bolts and reapplying the load, the tail piece on the outer or pulling flange gave way at a load of 32·8 tons. The pipe had a permanent increase in length of 4¼in. Heavier pulling flanges were then fitted, and the pipe drew down uniformly to an outside diameter of 2¼in., and subsequently necked down locally and broke 14in. from the nearest weld at a load of 35·2 tons. The total elongation was approximately 11in., and the approximate ultimate tensile strength 27·2 tons per square inch.

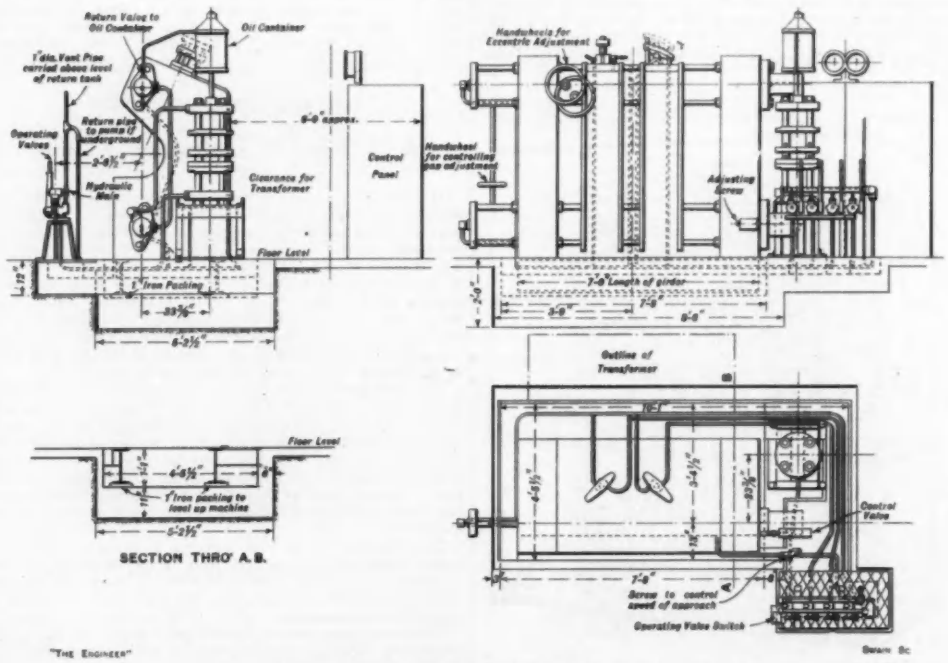


FIG. 2—HYDRAULICALLY-OPERATED ELECTRIC BUTT-WELDER

A test of the relative fatigue resistance of this type of weld, as compared with the ordinary type of screwed and expanded pipe, usually adopted, was then carried out, two similar tubes being fitted with flanges. Butt welding was adopted in one case, whilst in the other instance the usual method of screwing and expanding was employed. The pipes were revolved at 10 revolutions per minute in a lathe with a weight of 4 cwt. suspended at a length of 4ft. from the weld on a ball race. The welded pipe stood up to the test for 50 minutes, whilst the screwed and

expanded specimen gave out after 15 minutes. The approximate fluctuation of stress at the flange was about 14 tons per square inch ten times per minute.

Lloyd's Register of Shipping has approved of the method being adopted on oil fuel pressure pipes, feed discharge pipes, oil engine starting air pipes, oil engine injection air pipes and steam pipes for pressures up to 100 lb. per square inch, provided that in all cases they are carefully annealed on completion.

A brief description of the method of operating the machine will enable the process to be understood. The two parts to be welded—*i.e.*, the pipe and flange or two lengths of pipe—are clamped in the heads of the machine by moving two levers which control the two hydraulic clamping cylinders on the heads of the machine. The main hydraulic valve is then opened by a movement of a third lever which simultaneously switches on the current to the transformer of the machine. At this point, the patented automatic control comes into operation and allows the head carrying one of the units to be welded to approach the other unit at a speed which ensures that the metal in contact is being flashed away as fast as the heads approach each other. This maintains a light contact at the ends of the metal, with the result that the electrical resistance at this point is kept high and a maximum heating effect is obtained at the joint. This operation continues until the extreme edges of the metal are raised to a welding temperature, and, when that temperature is reached, the current is automatically switched off and a heavy forging pressure, depending on the section that is being welded, is rapidly applied to the weld. This completes the forging process and ensures a joint of homogenous section by forcing out any oxidation or other impurities from the weld, while increasing the density of the metal and the strength of the weld. The machine may be operated on any A.C. supply system of commercial voltage and may be connected to a hydraulic supply of from 1000 lb. to 2200 lb. per square inch pressure.

The machine covers a wide field of application and may be used for the welding of steam pipes and flanges. There is little doubt, the makers consider, that the process will be extended to higher pressures, and when operators and firms come to realise its benefits its use will be extended to other branches of shipyard work.

Railway companies, we are told, are adopting the method for the re-ending of their smoke and superheater tubes, and the system is said to result in a considerable saving in production costs. A well-known firm of boiler-makers in the country has also adopted the process for the automatic welding of superheater elements that may have to withstand pressures up to 1000 lb. per square inch and temperatures up to 800 deg. Fah. By eliminating the human element in the control of the welding and by the application of the most up-to-date mechanical electrical and metallurgical knowledge, the makers of the machine have placed the system on a sound production basis.

B.E.S.A. SPECIFICATIONS.

ROOFING TILES.

Architects, builders, house purchasers and manufacturers of roofing tiles throughout the United Kingdom will welcome the publication of a British Standard Specification for Clay or Marl Plain Roofing Tiles. The specification covers hand and machine-made clay and marl plain roofing tiles, with the exception of those definitely manufactured to meet special decorative requirements. Clauses are given relating to manufacture, size and thickness of the tiles, and tests are included to determine the degree of resistance of the tiles to the effects of water and frost. A strength test is also included to indicate ability to withstand stresses likely to be experienced during the course of the life of the tile. These tests are easy to carry out and a full description of the method of test is given.

The establishment of a fair standard of quality for tiles should be of considerable benefit to the manufacturer who has, up till now, had no recognised basis of comparison with the cheaper but definitely inferior article.

In addition to the description of tests, an appendix is included giving useful data, provided as a guide for the user, indicating the number of tiles required for a specific area when laid to varying gauges on the roof surface.

Copies of this new specification—No. 402, 1930—may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

CATALOGUES.

H. AND T. DANKS (NETHERTON), Ltd., Netherton, Dudley.—A booklet on jacketed pans.

ELECTROMERSIBLE MOTORS AND PUMPS, Ltd., Abbey House, London, S.W. 1.—Particulars of the Reed Cooper Electromersible pump.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, near Manchester.—A seventy-page brochure describing precision grinding machines for railway workshops.

ASEA ELECTRIC, Ltd., 5, Chancery-lane, W.C. 2.—Price list A.C.7, covering small single, two and three-phase induction motors, together with starting equipment.

FRASER AND CHALMERS ENGINEERING WORKS, Erith, Kent.—Particulars of the firm's pulverised fuel system for firing Lancashire boilers and metallurgical furnaces.

WESTMINSTER TOOL AND ELECTRIC COMPANY, Ltd., Putney Bridge-road, S.W. 15.—A booklet of "Westool" electric portable drills and grinders and flexible shaft driven tools.

GWYNNES PUMPS, Ltd., Hammersmith, W. 6.—Catalogue K1 of "K" type pumps for heads from 50ft. to 150ft., and a brochure of "K.L." type for heads from 15ft. to 60ft.

WADKIN AND CO., Green Lane Works, Leicester.—A folder illustrating some of the firm's woodworking machines, which include sawing cutting and trenching, planing, boring and mortising machines.

SAMUEL OSBORN AND CO., Ltd., Clyde Steel Works, Sheffield.—Booklets on "Rustless Plastic Iron," "Rustless Steel," "Tropic Fireproof Steel," "Acid-resisting and Deep Drawing Steel," "Corrosion-resisting Steel."

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Inactive Market.

THERE has been practically no business done on the Birmingham iron and steel market this week, and there have been no new developments in any branch of trade. Manufacturers had sufficient material to finish up the work which was to be completed before the works closed down for the Christmas break, and as the carry-over of orders was small, there was no necessity to lay in stocks ready for the resumption of activities. In many instances, too, stocktaking is undertaken between Christmas and the New Year, and manufacturers wish to facilitate it by having their yards as clear as possible. The majority of the iron and steel works and many of the engineering establishments have been idle during the whole of this week, and extended holidays are the general rule. It is uncertain when work will be recommenced at some of the Midland works, for orders on hand have been completed, and everything depends upon the receipt of new business. In a few special trades there is a moderate amount of work on the books, and at one of the Coventry automobile factories there has been a sudden speeding up of operations. All hands have been on full-time, except for a short Christmas vacation, and just prior to the 25th overtime was being worked in some departments. This, of course, is a very exceptional case, and it applies to one of the largest establishments, where, I understand, important developments are pending in the New Year. The weekly meeting of the Midland iron trade was not held this week, as it fell due on Christmas Day. The next gathering will be on the first of the New Year, when it is hoped a brighter and more optimistic spirit will permeate the proceedings. Everyone will be endeavouring to assess the prospects for 1931, and as gloomy forebodings are of no avail in helping towards a return to trade activity, they will be well left to die with the Old Year.

Pig Iron Rebate Scheme.

Midland blast-furnacemen have made another unexpected move. It takes the form of a rebate scheme, somewhat on the lines of the one in force in the steel trade. The scheme which has just been formulated by the Central Pig Iron Producers' Association, is based upon a six months' period, and applies only to large buyers, excluding merchants. Those consumers who give an undertaking not to use foreign material, and who take 1000 to 1500 tons of pig iron from local furnacemen in the six months will be entitled to a rebate of 6d. per ton. The scale rises to 9d. where purchases amount to between 1500 and 3000 tons, and to 1s. in the case of over 3000 tons. It is claimed for the scheme that it is not only a method of fighting foreign competition, but that it meets to some extent the claim of the big consumer that he should be treated better than the buyer whose requirements are relatively small. While it has met with approval in many quarters, there are naturally outcries against it from merchants and small firms, but owing to the inactivity on the market and the very small attendances on the Exchange in Birmingham since the scheme was announced, the general attitude towards it is not clearly evident. More will be heard of it no doubt at the next weekly meeting of producers and consumers. It is impossible to trace business having been given to continental ironmasters since Midland iron prices were reduced, and there is no reason to believe that any such orders have been given out. Under these circumstances the necessity for this move on the part of blast-furnacemen from the foreign competition point of view is difficult to understand. True there are small consignments of continental iron still coming into this district, but they appear to relate to old orders given during the short period when competition from this source was effective. It is no longer so. Northamptonshire and Derbyshire smelters have a certain amount of business booked for the early weeks of the New Year, but it does not amount to very much. Stocks, especially in Northamptonshire, are heavy, output having exceeded demand for some time past. Selling prices are unchanged at the fixed minimum laid down by the Association.

Staffordshire Bars.

Slack conditions continued in the Staffordshire wrought iron trade until the closing down of the works for the Christmas holidays, and resumption prospects are not good. Some of the marked bar mills have a reasonable carry-over of orders, but in the other departments order books have been practically cleared, and unless fresh work comes in during the vacation the closure will be considerably lengthened. There is no change in the quoted rates for finished iron. Marked bars are £12 10s., Crown bars £10 upwards, common bars £9, and wrought iron tube strip £10 17s. 6d.

Steel.

Most of the steel works in this area are short of specifications and report general conditions to be dull. Buying is of a very meagre character, but hopes of improvement in the New Year are held by most producers. In the finished steel branch there is no alteration on the past week, either in the volume of business passing or in prices. In the half products department demand is quiet, both as regards native and foreign material. Staffordshire steel hoops which have stood at £10 per ton for a very long time have now been reduced 10s. per ton, making the new selling figure £9 10s.

Galvanized Sheets.

Trade continues sluggish in the galvanised sheet industry and mills are extremely short of work. There is no improvement in the overseas demand, and the home trade is insufficient to keep the mills going. Values are, as a week ago, on the basis of £11 5s. per ton for 24 gauge corrugateds.

Interesting Data.

Manufacturers in many branches of industry in the Midlands and Staffordshire are interested in the striking statistics given by the President of the Board of Trade in reply to Mr. Hannon's questions concerning imports that compete with the products of local industrial firms. The quantity of chain cables, chains, and springs imported into Great Britain and Northern Ireland in the first ten months of this year was 3800 tons and their value was £127,383. Safes, cash and deed boxes to the value of £53,590 were imported, while the value of metallic furniture and bedsteads was £137,613. Stores, grates and ranges to the value of £243,151 were sent here from abroad. Imports of wire goods, not including telephone and telegraph cables, totalled in value £860,950, implements and tools £901,028, tubes, pipes and fittings £1,240,377. The only satisfactory statistics refer to iron and steel window frames and casements, imports of which were negligible.

Cannock Miners Accept Spread-over.

I am happy to be able to report that the miners in the Cannock Chase and Pelsall coalfield have decided by vote in favour of the spread-over terms offered by the local coalowners, thus reversing their previous decision. The 7½-hour day, which they have been operating under temporarily, is now abandoned, and the men are now working eight hours on five days a week and five hours on Saturday, with pay for three-quarter day and pay at the rate of 42 per cent. on the wage basis. This means that there will be no reduction in wages, and the minimum wage of stallmen will continue to be 9s. 4d. per day. As at present arranged, this rate of pay is assured to the men until March next.

Welded Tube Works Close.

The welded tube side of the Talbot Stead Tube Works, Green-lane, Walsall, is to be closed down permanently, as the section is being taken over by Stewarts and Lloyd's. About 100 men will be affected by the cessation of activity in this department of the works.

Contracts.

The Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., of Birmingham is to supply fifty-eight covered goods wagons to the Kenya and Uganda Railway. J. Tildesley, Ltd., of Darlaston, Staffs., are to supply a steel-framed building to the Great Western Railway Company for erection at Evesham.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery Slump.

THE extent of the decline in the export demand for textile machinery is reflected more in the official trade returns for November than at any other period this year, for they are well below the average for the previous ten months, and are barely half what they were in the corresponding month of either of the two previous years. The quantity exported in November amounted only to 5261 tons, valued at £515,044, compared with 11,746 tons, and £1,052,933 in November, 1929. Except for a rise in shipments to Russia—a year ago the takings by that country had shrunk almost to vanishing point—and a slight increase in exports to France, all other markets have undergone remarkable declines. British India leads the way with shipments valued at £145,812, although these are less than half the value in the corresponding period of last year. France is second with £73,758, followed by Russia with £42,866, Germany £34,757, China £21,496, South America £20,095, the Netherlands £16,621, the United States £11,764, Japan £10,639, and Australia £5277, "other European countries" accounting for shipments valued in the aggregate at £101,470. Over the eleven months to the end of November, exports of textile machinery have declined from £10,794,935 a year ago to £8,143,525.

Manchester-Isle of Man Air Service.

Beginning in the spring an air service between Manchester and the Isle of Man, consisting of three machines of the amphibian type in each direction, will be put into operation by Northern Air Lines, working from the Manchester Airport at Barton. At about the same time a service between Manchester and North Wales will be inaugurated, and plans are also under consideration for establishing a regular service between here and Ireland.

Fleetwood Dock Extension Scheme.

A conference between representatives of the London, Midland and Scottish Railway Company and of Fleetwood fishing industry interests has been held during the past few days to consider the port development project which the railway company has in hand in connection with Fleetwood, and a further conference will be held in January. The estimated cost of the scheme is in the neighbourhood of £750,000 and a Bill is to be presented to Parliament. For the purpose of experimental work, it was announced that a working model, to cost £1600, is to be constructed before actual operations are to commence.

Additions to Work.

The Manchester firm of Henry Simon, Ltd., has in hand a contract, valued at about £800,000, for a terminal elevator for the Buenos Aires Great Southern Railway Company. The elevator will have a storage capacity of 80,000 tons of grain, and will be able to take in grain at the rate of 1500 tons an hour and to load ocean-going vessels at the rate of 6000 tons an hour. When completed, the elevator in question will easily be the largest in the Argentine Republic. Orders for 250 machines of

a large type have, it is announced, been secured by Howard and Bullough, Ltd., textile machinery makers, of Accrington.

Personal.

Mr. Allan W. Rippon, until recently managing director of Henry Bessemer and Co., Ltd., Sheffield, has joined the board of directors of Platt Bros. and Co., Ltd., textile machinists, Oldham. Mr. John Hughes has also been co-opted on the board as an employee-director.

Iron and Steel.

Buying interest in iron and steel in this area has shrunk to very small proportions, and a quiet time is expected during the next few weeks, quite a number of important engineering works locally having decided to suspend operations for extended periods of up to about two weeks. Very little business is being done in pig iron, quotations for which are held at 69s. 6d. for Midland brands of No. 3—Derbyshire and Staffordshire—64s. 6d. for forge iron, from 90s. 6d. to 91s. for Scotch foundry, and about 84s. 6d. per ton for West Coast hematite. Lancashire bar iron continues to be quoted at £10 5s. per ton for Crown quality material and about £8 15s. for No. 2. Except that small re-rolled bars are now at a top figure of about £7 5s. per ton, there has been little alteration in the steel position, so far as prices are concerned, and the demand in virtually every section of the market during the past week has been extremely poor. General plates are quoted at £8 17s. 6d. per ton, sections at £8 7s. 6d., joists at £8 10s., large diameter bars at £9 7s. 6d., and boiler plates at about £9 7s. 6d. Prices for continental steel materials are nominally steady at late rates, but very little business has been booked on this market during the past week or so.

SHEFFIELD.

(From our own Correspondent.)

Holidays and Trade.

MOST of the large steel works arranged for a long Christmas holiday, and this provides further evidence of the unsatisfactory state of trade at the present time. Conditions are so dull, in fact, that several firms found it necessary to close down for three weeks. When many works restart it is expected that there will be very few orders to tackle, and the extent of the resumption depends on how much work comes in during the next few days. Prospects are far from bright, for there are few inquiries of any importance and there are no signs of any early revival in buying. On the other hand, it is felt that users of iron and steel materials throughout the world must have approached the point of exhaustion of their stocks, and for that reason it is hoped that there will be an improved demand before many months are over. Trade with overseas countries is especially disappointing, and there are no prospects of improvement in this section at the moment. Conditions are particularly quiet in the heavy iron and steel branches, and with such costly plants and overhead charges to maintain for an output which must be considered comparatively small, the financial drain upon the producing companies is a heavy one. Although there are several large engineering contracts in course of execution, this class of work is difficult to get and competition is consequently keen. The lighter branches of engineering are a little more favourably placed, but, here, again, firms do not find it possible to operate their plants on a fully profitable basis.

Huge Turbine Shafts.

The Sheffield works of the English Steel Corporation are contributing a very important part in the great power scheme which is being carried out at Beauharnois, 22 miles from Montreal, for the purpose of harnessing the waters of the St. Lawrence River, as they are making the turbine shaftings to be used in the work. These shafts are among the largest in the world. They have a diameter of 38in. and weigh about 42 tons each, as forged, and 36 tons after machining. Part of this contract has been completed, but other shafts for use on this power scheme are on order from the Sheffield works of the corporation. A notable feat in heavy steel forging has been accomplished, for two shafts are forged together, thus giving the great weight of 84 tons. This gives a good idea of the gigantic engineering work that can be carried out in Sheffield. The Beauharnois scheme is the greatest single power development in the world. The horse-power at present being installed is 200,000, and this is ultimately to be increased, at the rate of probably 100,000 per annum, to a total of 2,000,000. An 80ft. head of water is to be secured.

Combined Technical Resources.

An arrangement has been made between Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield, and the well-known Allis-Chalmers Manufacturing Company, Milwaukee, U.S.A., under which the former firm will manufacture at Sheffield and sell in certain parts of the British Empire and Asia various types of Allis-Chalmers crushing and grinding machinery. The arrangement does not apply to Canada and the sales organisation of the Allis-Chalmers Manufacturing Company in Paris, London and South Africa will not be affected in any way; but firms in the crushing, grinding and cement industries will, it is stated, have, in many instances, the advantages of the combined technical resources of the two companies, together with British manufacture should they prefer it.

Contract for Army Razors.

The contract for the complete equipment of the Irish Free State Army with Wardonia patented safety razor holders and the requisite number of "New Edge" blades has been given to Thos. Ward and Sons, Ltd., cutlery and razor blade manufacturers, Wardonia Works, Sheffield. The firm is not allowed to disclose the amounts of the contracts, but it states that it is particularly large and will necessitate the employees shortening their Christmas holidays. The contract was secured against severe competition of both home and foreign manufacturers. Mr. Thos. W. Ward, the managing director of the company, states that the placing of the contract is a triumph for Sheffield goods, and will give an impetus to the sale of Sheffield articles in the Irish Free State.

Waterworks Schemes.

Two reservoir schemes are the subject of discussion in this district. The Bakewell Rural Council has decided that it will have to build a new reservoir and to abandon the one completed in 1927 at a cost of nearly £13,000. Upon completion the reservoir, which is at Eyam, in Derbyshire, was found to be leaking and it has given much trouble since. There are now two cracks, one of $\frac{1}{8}$in. in the coping and one of $\frac{1}{4}$in. in the wall. The Council engaged the services this year of Professor Morton, of Victoria University, Manchester, as geologist. Following the Council's decision to abandon the reservoir, the engineers are to confer with the local representatives respecting a suitable site. It is expected that the plans for the new reservoir will be presented next month, but the exact nature of the scheme has not yet been decided upon. The other reservoir, which is at present the subject of discussion, is the one at Ewden, which was built by the Sheffield Corporation at a cost of £1,750,000. This was opened a year ago, but flaws were discovered in the strata of the valley, and it became necessary to undertake repair work on an extensive scale. The geological defect was unforeseen, but the principal difficulty remaining is the effective treatment of purely outside work in connection with what is known as the Waldershelf slip. The reservoir has been empty since the opening, and the work that has been carried out has included the pumping of large amounts of liquid concrete into the earth in an endeavour to remedy the influence of defective strata.

Industrial Mission's Return.

Sheffield manufacturers have given a cordial welcome to the Sheffield Industrial Mission to South America. The two members of the Mission, Mr. A. K. Wilson and Mr. C. R. Hodgson, representing, respectively, the Cutlers' Company and the Chamber of Commerce, when interviewed on their return to Sheffield, spoke optimistically of the prospects of improved trade with the South American countries. They have acquired an extensive knowledge of the particular requirements of these markets, and have brought back with them over 400 samples of goods required by the South Americans. One important suggestion which they are putting forward is that firms manufacturing non-competitive lines should co-operate in a group selling organisation, and they are confident that with such co-operation there should be considerable improvement in trade with the countries they have just visited. It appears that there is greater scope for the lighter industries than the heavy trades, and it is suggested that the small manufacturer, provided with essential information he could not secure for himself, will benefit most from the Mission's experiences and advice.

NORTH OF ENGLAND.

(From our own Correspondent.)

Shipbuilding Records.

THE total output of shipbuilding tonnage on the Tyne this year has exceeded that of last year, which is highly satisfactory in view of the conditions prevailing, but the unfortunate aspect is that so little work is left in hand, and the outlook is anything but bright. Returns to hand reveal that the Wallsend firm of Swan, Hunter and Wigham Richardson, Ltd., has launched more tonnage than in any year since 1906, when the building of the "Mauretania" gave them a record year. The shipbuilding output of Armstrong, Whitworth's is also disclosed as being twice the amount of last year. Swan, Hunter and Wigham Richardson had an actual output of 213,229 tons for the year from their shipyards on the Tyne, the Clyde and the Wear. This figure is 51,772 tons more than last year. The Tyne alone saw the launch of 125,193 tons. This figure approaches the record of 1926, when 126,921 tons constituted the output. This has been the most productive year for the Tyne for eighteen years. The year's tonnage represented twenty-one ships, thirteen of which were for foreign shipping firms. Last year twenty-nine vessels were built on the river, but the gross tonnage was about 200 short of 100,000. The return of Armstrong, Whitworth's shows that thirteen ships were built by the firm during the year, with an aggregate tonnage of 88,395, as against ten vessels of 44,070 tons last year. Eleven of the thirteen vessels launched by this firm were motor tankers for Norwegian owners. Another satisfactory return is that of Palmer's Shipbuilding and Iron Company, which has secured contracts to build two new destroyers under the Government naval plan. Palmer's have an output this year of 65,896 tons, compared with 50,403 tons. The total output of eleven vessels for the year by R. and W. Hawthorn Leslie, Hebburn, is greater by one vessel than last year, while the total tonnage shows an increase of 8778 tons. Returns from marine engineering firms also reveal big increases.

Wear and Tees.

On the other hand, considerably reduced outputs are recorded on the Wear and Tees. The total output on the Wear was forty vessels, aggregating 175,499 tons, as compared with fifty-eight vessels, totalling 245,469 tons in 1929. The output in 1929 was the most hopeful since the boom year of 1920, when sixty-seven vessels, amounting to 333,335 tons, were launched. With the exception of Smith's Dock Company, there were reduced outputs in all the Teesside shipyards and engineering establishments. The 1930 output has, in fact, been the lowest since 1926. Craig, Taylor and Co., Thornaby, have not launched a single vessel, and the three firms still working turned out fifty-four vessels of a total tonnage of 122,517, as compared with seventy-six vessels with an aggregate of 194,181 tons, by four firms last year. The prospects for the Wear and Tees yards for next year are not at all promising. Very few orders are held, and there are no new inquiries.

Cleveland Iron Trade.

The Cleveland pig iron market is without any feature of moment. Business has fallen off considerably, but this is the usual experience at this season of the year. Deliveries have been largely suspended over the holidays, and as consumption at the steel works has also ceased, a large increase in the stock of pig iron is inevitable. Both from the Midlands and from abroad pig iron is being brought into this district at prices below the local quotation, and the belief is gaining ground that reductions in the fixed prices are almost certain. This, however, is not likely to come until after the holidays, and current quotations are unchanged. No. 1 Cleveland foundry iron is 66s., No. 3 G.M.B. 63s. 6d., No. 4 foundry 62s. 6d., and No. 4 forge 62s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade has weakened a little, and it is now possible to buy mixed numbers at 70s., though some producers are holding out for more on forward account. No. 1 quality is at a premium of 6d. per ton. Makers are handicapped by heavy stocks, and these will be increased during the holiday period, when the blast-furnaces are kept in full operation and the consuming works are closed.

Ironmaking Materials.

There is next to nothing being done in foreign ore, and best Rubio is nominal at 16s. c.i.f. Tees for prompt, but that figure will not be accepted for forward delivery. There is rather more inquiry for blast-furnace coke, but 17s. delivered at the works is an unchanged quotation.

Manufactured Iron and Steel.

The manufactured iron and steel trade shows little signs of revival, but no variation has been made in the fixed home prices. In some branches new orders are urgently needed. Most of the works on the North-East Coast have closed down until the beginning of next week.

The Coal Trade.

The Northern coal market generally has slowed down. Merchants and other shippers have covered all their requirements over the holiday period or up to the end of the first week in January. With limited stocks on offer for the next fortnight, the market is very quiet. There is little inquiry, and fitters are well booked and stemmed with tonnage to the end of the year. The tone for all Northumberland steam qualities is quite firm up to early January, but there is considerable anxiety as to more forward business, owing to lack of inquiry. The January position is therefore very irregular. Best Northumberland steams command 13s. 6d. to 13s. 9d., and secondary qualities about 12s. Heavy prompt bookings and good January prospects give a firm tone to all qualities of Durham gas coal, which are held to a firm minimum of 15s. Secondary gas are also in a strong position at 13s. to 13s. 9d., according to date of shipment. Coking unscreened are steadily held at 13s. 6d. to 14s. Good unscreened bunkers are at 13s. 6d., and best at 14s. to 14s. 6d. The coke trade position is quiet, but gas coke owing to limited supplies is quoted firmly at 21s. 6d. Patent oven coke is in better request, but ample stocks keep prices steady at 17s. to 17s. 6d. Beehive and superior coke is scarce and firm at 24s. to 28s. 6d.

SCOTLAND.

(From our own Correspondent.)

Continued Depression.

THE year is drawing to a close without bringing any sign of trade improvement. During the month of November the industrial position practically reached the low-water mark and the succeeding weeks have not brought any improvement. Practically all steel and iron works are on short time, few, if any, being able to start the week before Tuesday morning, and only the more fortunate being able to continue until Friday evening in any week. The New Year holidays are likely to be prolonged, but there is no indication of any inclination on the part of consumers to anticipate their requirements over the vacation.

Steel.

There has been a little more inquiry on export account, more especially from India and South America; but, on the whole, there is a lack of confidence in the market, and any improvement is likely to be slow. At the same time, it may, perhaps, be said that the quiet feeling of optimism, which has been referred to in these notes on occasions of late, seems to have spread to other quarters, and it is hoped that events, after the turn of the year, may justify such aspirations. Up to the present inquiries in circulation have brought little in the way of tangible result, but the most recent advices appear to indicate a more genuine interest in British products. Meanwhile, heavy steel is quiet, both on home and export account. Steel sheet makers have more orders on hand, but are still working short time. The latest reduction of 7s. 6d. per ton in the price of galvanised sheets has been productive to some extent. The tube trade is most disappointing. About twelve months ago this department was the bright spot in the steel industry, while to-day the position is most discouraging, the average working week being one of three days. Several works were idle all last week.

Iron.

Since the completion of the orders of iron tube skelp for Canada, the bar iron works have been extremely

quiet, while the steel bar re-rolling departments also have been comparatively inactive, despite the easier prices of £7 7s. 6d. per ton home and £7 5s. export.

Pig Iron.

Business in pig iron continues to decrease, and the production has been further reduced, there being only six furnaces now producing iron in Scotland. Considerable quantities of pig iron still continue to arrive from the Continent and India, the latest consignment being one of 2350 tons from India.

Scrap.

The demand for scrap has dwindled, and something less than market quotations of 60s. cast iron machinery and 50s. per ton heavy steel will be accepted on occasion.

Coal.

So far as supplies are concerned, the Scottish coal market has not recovered from the recent stoppage during which the collieries became in arrears with deliveries The production has been gradually improved, but supplies are still short. Exporters show little interest at present, the prices quoted being altogether too high to give them any chance of securing business abroad. Home demands are below normal, and collieries have great difficulty in securing the seasonal advance in prices.

Shotts Pit to Reopen.

A pit at Shotts, which has been closed for three years, has been reopened, and all the Shotts pits are now working. The pit belongs to the Shotts Iron Company.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Business in coals has practically terminated for this year. There were definite indications last week that operations, which at the best were on a small scale, were coming to an end. All concerned with the coal export trade will have few regrets at the passing of 1930. It has been a difficult year. It has not been a prosperous year for traders, and it has been a most unsatisfactory period for the workers at the pits. Irregular employment has been a feature throughout the whole twelve months, with the result that it will not be surprising if the total coal production for South Wales amounts to not more than approximately 44,750,000, which is a reduction of about 4¼ million tons as compared with the preceding year. Shipments of coal, coke, and patent fuel, foreign and coastwise, and as bunkers will probably be in the neighbourhood of 29,400,000 tons, as compared with 31,745,996 tons for 1929 and with 41,378,178 tons for 1913. Every effort has been made by the leading firms of producers and exporters to maintain their hold on the markets abroad, but the fact has to be faced that the competition of foreign producers has been keener than ever and considerable trade has been lost, particularly in South America, while the reduced costs of production have enabled continental fuels, especially Polish coals, to keep a strong footing in the Northern European markets. So far as prices of South Wales coals are concerned, they have presented no feature during the past year, for the reason that there has scarcely been any variation, such as was witnessed in the old days when free conditions prevailed. Prices have been subject to regulation throughout the whole year. For the greater part of the year it was done by voluntary arrangement, while since the passing of the Coal Mines Act they have been, of course, compulsory in conjunction with the scheme for the regulation of production. During the first quarter of the year the minimum schedule of prices was reduced, the changes in the various qualities of coal varying from 3d. to about 1s. per ton. The result is that for practically the past nine months there has been no alteration in prices, as the minima figures have prevailed throughout, the demand for coals being insufficient, except in a few isolated instances, to justify collieries asking for higher prices. As to the future of the industry, it is impossible to look forward with feelings of unqualified optimism, as unless international co-operation is entered into there can only be keener international competition, and, furthermore, the position is complicated by the uncertainty which prevails regarding the negotiations now proceeding respecting the new wages agreement to apply to the coalfield.

Docks, Shipping, and Iron and Steel.

All industries allied to the coal trade have shared in the depression which has existed during the past year. The returns of traffic at the leading docks in this district have suffered materially, and the probability is that when the complete figures for the six ports, viz., Cardiff, Swansea, Newport, Barry, Port Talbot, and Penarth, are available, it will be found that the total is less by about 2¾ million tons, as compared with the aggregate for 1929. Imports have, on the whole, been well maintained, but the loss of traffic has, of course, been on the export side on account of the substantial reduction in coal and coke shipments. Ship-repairing operations have been less, which is only natural when it is borne in mind that less tonnage has traded to South Wales. Up to the end of November statistics showed that the number of vessels which had come to ports in this district was well over a thousand below the total for the first eleven months of 1929. In the iron and steel industry conditions have been far from satisfactory. The Ebbw Vale Works have been closed throughout the whole year, while Guest, Keen and Nettlefolds, Ltd., shut down their works at Dowlais-Merthyr. In the tin-plate section works operated for the most part up to about 75 per cent. of their capacity, though latterly the bulk of them have only operated to about half their capacity. The shipping industry has suffered acutely during the past twelve months. It is questionable whether, except in rare instances, shipowners have been able to employ their tonnage on a remunerative basis. At one time during the year steamers aggregating 181,426 tons net register were laid up at South Wales ports, while the total for the whole of the United Kingdom ports was 927,717 tons net register. Rates of freight homeward have been on a reduced scale, while outward freight rates for coal from South Wales ports have fallen below pre-war standards, in addition to which it has to be remembered that shipowners' running costs have advanced fully 60 per cent. The lowest rate for West Italy was 5s. 4d. and the highest 7s. 3d., which compares with 6s. 10½d. and 10s. 9d. respectively for the previous year. The average freight for the past year for Venice was 6s. 6¼d., as against 8s. 11¼d. for 1929; for Gibraltar, 6s. 1½d., as compared with 8s. 6½d.; for Barcelona, 8s. 11½d., as against 12s. 5½d.; for Alexandria, 7s. 1½d., compared with 11s. 7d.; and Rouen, 4s., as against 5s. 4¾d.

Dock Charges.

Representatives of coalowners, shipowners, and other trading interests met at Cardiff on Friday last to consider the clauses in the new Bill of the Great Western Railway Company relating to dock rates and charges. The company's proposal that the question of dock charges should be related to the net earnings of capital invested in the provision of dock facilities meets with the strongest opposition from all quarters. A deputation recently met the general manager of the company, when it expressed its views on the matter, and it is stated that an alternative suggestion was made with a view to the company and the traders coming to an agreement that existing charges should be stabilised for a fixed period of years. This latter suggestion, it is stated, was strongly condemned at the meeting of traders last Friday, while the Newport Chamber of Commerce, when the members discussed the subject later the same day, also showed the strongest opposition to the Great Western Railway Company's proposals, and decided to join with the Cardiff and other South Wales Chambers of Commerce and other trading interests in protesting to the company, with a view to the withdrawal or modification of the clause and section of the Bill relating to the matter.

Tin-plate Regulation.

Reference was made recently to the action of manufacturers of tin-plate in South Wales in abandoning the principle of minimum prices, which as a consequence have fallen from 17s. to 15s. 9d. to 16s. per basis box. Efforts have since been made by those members in the pool to persuade those outside to fall into line, and at a meeting held at Swansea recently it was stated that the Melingriffith Company had become a member of the pool, and efforts were being made to induce the few works remaining outside to join.

Current Business.

Business on the steam coal market fell to extremely small proportions at the end of last week, and it is very doubtful whether much will now be done before the New Year. Most exporters who had business to arrange for loading, both this side and immediately after the holidays, attended to it last week, and of the tonnage which has been recently chartered, a fair amount of it is for loading after Christmas. The position of collieries varies considerably, but most of them have moderately good bookings for the remainder of this year, and possibly for the first week of January. There is, however, no real loading pressure at the docks, as can be gauged from the fact that on Saturday last there were no less than twenty-eight idle tipping appliances at the various docks. Many steamers have, however, been delayed by bad weather, and now run the risk of being held up at their loading port right over the holidays. In view of the fact that business is practically at a standstill, coal prices are little more than nominal. Pitwood continues to be easy round about 26s. 9d. to 27s. 3d.

Steel Works to Resume.

The official announcement is made that the Llanelly Steel Company has decided to reopen its Llanelly works immediately after Christmas. These works have been closed for some months, owing to the severe continental competition and the heavy importation of steel bars. Work is to be resumed on the 29th inst., when it is expected that some of the smelting furnaces will be put into commission. It is understood also that the Llanelly Sheet Mills, which have been at a standstill since March last, will resume operations on the 29th inst. Over a thousand workmen are normally employed at these works. All tin-plate works are closed this week for the holidays. They will reopen on Monday, the 29th inst.

LAUNCHES AND TRIAL TRIPS.

San Mateo, single-screw steamer; built by Harland and Wolff, Ltd., to the order of Compagnie Generale Transatlantique, of Paris; dimensions, 430ft. by 57ft. by 37ft. 6in.; to carry cargo. Engines, triple-expansion, 31in., 50in., 60in., 60in. by 60in. stroke, pressure 205 lb. per square inch; constructed by the builders; launch, November 20th.

Gylfe, single-screw motor ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd.; to the order of Messrs. Eiv Evensen and Co., A/S, of Oslo; dimensions, 408ft. by 54ft. 9in.; to carry oil in bulk. Engines, oil, Armstrong-Diesel type; constructed by the builders; trial trip, November 24th.

Soudan, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of P. & O. Steam Navigation Company, Ltd.; dimensions, 458ft. by 60ft. 6in. by 40ft. 9in.; to carry cargo. Engines, quadruple-expansion, 30½in., 44in., 63½in., 91in. by 57in. stroke, pressure 230 lb. per square inch; constructed by the builders; launch, November 24th.

Attila, single-screw oil tank motor ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd.; to the order of Mr. Alf Jakhelln, of Oslo; dimensions, 476ft. by 59ft. 7in.; to carry oil in bulk. Engines, oil, Armstrong-Diesel type; constructed by the builders; trial trip, November 26th.

Calder, steam vessel; built by Cammell, Laird and Co., Ltd., to the order of the London, Midland and Scottish Railway Company; trial trip, November 27th.

Tobago, twin-screw steamer; built by J. I. Thornycroft and Co., Ltd.; dimensions, 150ft. by 29ft. by 12ft.; constructed by the builders; trial trip, November 28th.

Motor Tanker; built by James Pollock, Sons and Co., Ltd., to the order of London owners, for service in South America; dimensions, 91ft. by 18ft. by 6ft. 3in.; to carry petroleum spirit in bulk. Engines, 120 B.H.P., two-cylinder, Bolinders oil; trial trip, recent.

Sveve, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of A/S. D/S "Atlantic," of Bergen, Norway; dimensions, 435ft. by 57ft. 6in., to carry oil in bulk. Engines, oil, Wallsend-Sulzer type; constructed by the builders; a speed of 12½ knots was attained on trial trip recently.

Ollanta, twin-screw steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of Peruvian Corporation, Ltd., for service on Lake Titicaca, on top of the Andes, South America, 12,500ft. above sea level; dimensions, 265ft. by 35ft. 6in. by 14ft.; to carry passengers and 950 tons cargo. Engines, twin; constructed by the builders. The ship has been erected complete and then dismantled and packed in cases, and will be re-erected on the banks of Lake Titicaca; just completed.

Fan Aruba, oil tank motor ship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Mr. Leif Hoegh, of Oslo; dimensions, 483ft. by 65½ft. by 36ft. 0¾in.; to carry oil in bulk. Engines, oil, Wallsend-Sulzer type; constructed by the Wallsend Slipway and Engineering Company, Ltd.; launch, December 5th.

Rab, single-screw steel steamer; built by J. Samuel White and Co., Ltd., to the order of Messrs. Jadranska Plovidba d/d, of Susak, Jugoslavia; dimensions, 144ft. by 24ft. 6in.; to carry passengers and 120 tons cargo. Engines, triple-expansion constructed by the builders; launch, December 6th.

Aguila, motor vessel; built by Henry Robb, Ltd., Leith, to the order of Forestal Land, Timber and Railways Company, Ltd.; dimensions, 260ft. by 42ft. by 12ft. 6in.; to carry cargo. Engines, twin-screw motors; constructed by Atlas Diesel Company, of Stockholm; launch, December 8th.

Capulet, oil tank motor ship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of C. T. Bowring and Co., Ltd., Liverpool; dimensions, 460ft. by 59½ft.; to carry oil in bulk. Engines, oil, Burmeister and Wain type; constructed by John G. Kincaid and Co., Ltd., Greenock; launch, December 8th.

Aire, cargo ship; built by Cammell Laird and Co., Ltd., to the order of London, Midland and Scottish Railway Company; dimensions, 240ft. by 34ft. by 16ft. 4in. Engines, triple-expansion, 22in., 36in. and 61in. by 39in. stroke, pressure 200 lb. per square inch; constructed by the builders; launch, December 9th.

J. H. Fisher, pilot cutter; built by Earle's Shipbuilding and Engineering Company, Ltd.; to the order of Humber Pilots' Steam Cutter Company, Ltd.; dimensions, 140ft. by 26ft. by 13ft. Engines, triple-expansion, 13½in., 22in., 37in. by 24in. stroke, pressure 180 lb. per square inch; constructed by the builders; launch, December 9th.

Rockabill, steel screw steamer; built by D. and W. Henderson and Co., Ltd.; to the order of Clyde Shipping Company, Ltd., Glasgow; dimensions, 270ft. by 37ft. by 18ft. 9in.; to carry cargo. Engines, triple-expansion, 21in., 34in., and 56in. by 39in. stroke, pressure 185 lb. per square inch; constructed by the builders; launch, Wednesday, December 10th.

Steel swim barges; built by James Pollock, Sons and Co., Ltd.; to the order of London owners; dimensions, 83ft. by 20ft. by 6ft. 9in.; recently completed.

Langanbank, twin-screw motor vessel; built by Harland and Wolff, Ltd.; to the order of Messrs. Andrew Weir and Co.; dimensions, 425ft. by 57ft. by 38ft. 7in.; to carry cargo. Engines, oil, Harland-B. & W. type; constructed by the builders; trial trip, December 11th.

Adellen, oil tanker; built by Blythswood Shipbuilding Company, Ltd.; to the order of Adellen Shipping Company, Ltd., of London; dimensions, 460ft. by 60ft. by 34ft. 6in.; to carry oil in bulk. Engines, oil, Burmeister and Wain and Harland and Wolff system; constructed by John G. Kincaid and Co., Ltd.; trial trip, Friday, December 12th.

Athelbeach, single-screw motor tanker; built by Cammell Laird and Co., Ltd., to the order of United Molasses Company, Ltd.; dimensions, 425ft. by 55ft. 9in. by 32ft. 3in.; to carry oil in bulk. Engines, oil; constructed by Messrs. J. G. Kincaid and Co., of Glasgow; handed over December 16th.

Sao Miguel, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Messrs. Companhia de Navegacco Carregadores Acoreanos; dimensions, 290ft. by 42ft. by 19ft. 11in.; to carry passengers and cargo. Engines, triple expansion, pressure 200 lb. per square inch; constructed by the builders; launch, December 18th.

CONTRACTS.

Merryweather and Sons, Ltd., of Greenwich, have been entrusted with the fire protection arrangements for the forthcoming British Empire Trade Exhibition to be held at Buenos Aires from March 14th to April 27th, 1931.

The British Thomson-Houston Co., Ltd., Rugby, has obtained an order for two 75,000-kW. turbo-alternators from the County of London Electric Supply Company for the new Barking Extension. These machines are the largest yet ordered in this country.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Fry's (London), Ltd., asks us to announce that its head office and warehouse will, in future, be combined at 24–5, King-street, Minories, London, E. 1. Telephone: Royal 6152.

The Association of Special Libraries and Information Bureaux has moved to new offices at 16, Russell-square, London, W.C. 1. The telephone number and telegraphic address will be unchanged, *i.e.*, Fitzroy 1010 and "Asliburo, Westcent, London."

Board of Trade Engineer and Ship Surveyors.—A competitive examination for two or more appointments as Engineer and Ship Surveyor under the Board of Trade will be held in London on March 17th, 1931. The limits of age are from 25–40 years, and the salary is from £300 to £500, plus bonus, which is at present £114 9s. on the salary of £300. Candidates must possess either an Extra First-class (Board of Trade) Certificate of Competency as Engineer, or a First-class (Board of Trade) Certificate of Competency as Engineer, together with a B.Sc. (Engineering), or other equivalent voucher of scholarship. Applications are to be made not later than February 3rd, 1931, on the special forms, obtainable from the Senior Staff Officer, Establishment Department (Mercantile Marine Branch), Board of Trade, Great George-street, London, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/9 to 22/6
(1) Spanish	17/– to 20/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
„ „ Foundry	3 11 0	—
(c) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (*a*); 4 5 6 (*b*); 4 10 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 15 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 5 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 7 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 5 0	—
Hoops	10 5 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars	7 7 6 to 8 5 0	—
Billets and Sheet Bars	5 12 6 to 6 10 0	—
Galv. Sheets, f.o.b. L'pool	11 5 0	—
(2) Staffordshire Hoops	9 10 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 7 6 to 9 10 0	—

NON-FERROUS METALS.

SWANSEA*—	
Tin-plates, I.C., 20 by 14 f.o.b.	15.9 to 16/–
Block Tin (Cash)	105 10 0
„ (three months)	106 15 0
Copper (cash)	44 5 0
„ (three months)	44 1 3
Spanish Lead (cash)	14 17 6
„ „ (three months)	14 17 6
Spelter (cash)	13 6 3
„ (three months)	13 6 3
MANCHESTER—	
Copper, Best Selected Ingots	53 0 0
„ Electrolytic	51 10 0
„ Strong Sheets	77 0 0
„ Tubes (Basis Price), lb.	0 0 11½
Brass Tubes (Basis Price), lb.	0 0 10
„ Condenser, lb.	0 1 0½
Lead English	16 12 6
„ Foreign	15 5 0
Spelter	14 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 5 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 0 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/–
„ „ „ 0·70 p.c. carbon	£41 0 0	14/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 5 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£18 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	10d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/6
„ „ Ell	15/–
„ „ Splint	15/6 to 16/6
„ „ Trebles	14/– to 14/6
„ „ Doubles	13/3 to 13/6
„ „ Singles	12/9 to 13/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	18/–
„ „ Trebles	14/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/– to 13/6
Screened Navigation	16/6 to 17/6
Trebles	14/6 to 16/6
Doubles	13/–
Singles	12/6 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/6
Secondary Steam	12/–
Trebles	13/6 to 14/6
Doubles	12/6 to 12/9
Singles	12/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams	20/6 to 21/–	
Household	32/6 to 53/6	
Coke	21/– to 22/–	
NORTHUMBERLAND—		
Best Steams	13/9 to 14/3	
Second Steams	13/– to 13/3	
Steam Smalls	10/– to 10/6	
Unscreened	12/6 to 13/–	
Household	25/– to 37/–	
DURHAM—		
Best Gas	15/–	
Second	13/6	
Household	25/– to 37/–	
Foundry Coke	24/– to 26/–	
SHEFFIELD—		
Best Hand-picked Branch	25/6 to 27/–	—
Derbyshire Best Bright House	20/– to 22/6	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	18/– to 19/–	—
„ „ Nuts	15/6 to 16/6	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	6/6 to 7/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	11/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 15/6 to 16/–		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/–
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/6 to 17/7½
Best Steam Smalls	13/6 to 13/9
Ordinary Smalls	11/6 to 12/9
Washed Nuts	17/6 to 22/6
No. 3 Rhondda Large	20/– to 20/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 35/–
Furnace Coke (Export)	17/6 to 20/–
Patent Fuel	21/6
Pitwood (ex ship)	27/– to 27/3
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 28/–
Peas	20/3 to 21/6
Breaker Duff	9/9 to 10/3
Rubbly Culm	9/– to 9/6
Steam Coals :	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 : Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

* Prices for Swansea metals not available in time for this week's issue.

French Engineering Notes.

(From our own Correspondent in Paris.)

Trade Tendencies.

FOR several months past the foreign trade returns have revealed facts which are modifying ideas upon the future conditions of industry. Leaving aside the exchanges of agricultural produce, which are the principal feature of the returns, the exports of steel products and other "material necessary for industry" have been declining, while the imports, principally of coal, have increased. Of more significance are the diminishing values of manufactured goods, notwithstanding a small increase in quantity, and the steady rise in the imports of manufactures, both in quantity and value. There are few things now which the French engineering industry is not producing in competition with similar foreign manufactures; but, as it aims at supplying the home market, and can have little hope at present of competing for foreign business, the production is limited and the costs relatively high. The claim of French manufacturers that their elevating machinery, rock drills and other productions are as good as the foreign does not prevent a steadily increasing importation of such material. There is a slackness everywhere in the home industries, except in railway rolling stock and electrical machinery. Those most seriously affected are machine tool makers and motor car firms. It appears as if the French industrial development has reached a phase in which it is overtaken by a contrary movement proceeding in other countries. In France, the industrial activity that continued until a year ago did not point to the necessity of taking particular precautions against the future; but, since then, living costs have increased and have entirely changed the outlook. A heavy increase in national expenditure has been accompanied by high taxation, and upon that was imposed the compulsory insurance which produced an immediate advance in the cost of everything. The result has been a continuous rise in manufacturing costs at a time when wages and production costs have fallen in other continental countries. While this tends to eliminate French competition in other markets, it facilitates foreign competition in this country. German manufacturers are particularly successful in their efforts to do business here, partly because they have already secured valuable connections as the result of the supply of reparation material and, more especially, on account of the low prices they are able to offer. The Minister of Commerce has found it necessary to issue a circular inviting the port authorities and others to place no orders for machinery and material abroad until they are assured that the same goods cannot be obtained under reasonable conditions from French manufacturers.

Lille an Inland Port.

The inland waterway system in the Northern Departments is being developed transversely between Alsace and Dunkirk. There is not much probability of water communication with Paris being improved by the construction of the proposed new canal, for the existing canal and the railways can deal with all the coal that is sent to the capital. The transversal waterways are of far greater importance, for the reason that they pass through vast industrial agglomerations, and, more particularly, because Dunkirk is anxious to draw from Alsace the traffic that at present goes by the Rhine to Antwerp and Rotterdam. Canals are being deepened and widened and new ones constructed to shorten distances, and they are all being equipped electrically with traction by trolleys and tractors. When sufficient experience has been obtained with the different systems of traction, they will be unified as far as possible. This will permit of an accelerated service of 600-ton barges, of the type that navigate the Rhine, and when the waterway improvements are completed it is hoped that some of the traffic with Central Europe will pass through Dunkirk and the North of France. In view of these developments work is to be put in hand almost immediately for the creation of a port at Lille on a part of the fortifications that are being dismantled. This will involve the construction of new canals, one to the north of the city, which will thus be surrounded by the waterway, and the port will be laid out along the new canal joining the Deule, where it will have a width of 115ft. over a distance of 1 kilom. There will be a complete equipment of elevating machinery, grain elevators and warehouses, and connections with the railway system. This will be the only inland port served exclusively by canals.

Rural Electrification.

The national electrification scheme was evolved with the idea of solving problems arising out of the depopulation of rural districts with a consequent restriction of agriculture and a decay of local industries. It was hoped that these would revive, and people would return to the land, when electricity provided all that was necessary for power purposes and for country amenities. The work is well advanced, and electricity has been distributed over the greater part of the country; but, so far, the situation does not appear to have improved to an appreciable extent. The trouble is that people in rural districts will not make a free use of electricity because it is too dear. There was too much promise of cheap electricity at the beginning, when it was stated that the companies would charge preferential rates for country consumption at the expense of town consumers, who would be required to pay higher prices. The system, of course, failed, and the companies found, moreover, that the cost of distribution in extensive and thinly populated areas was greater than had been estimated. The problem that must be solved before the electrification scheme can become a complete success is to bring down the cost, which is due to heavy initial charges. Considerable indemnities, too, had to be paid for the damage caused by the blowing down of lines during the violent storms a few months ago. As a means of encouraging the use of electricity in rural areas, the Paris and Orleans Railway Company is running over its system a demonstration train composed of ten coaches, equipped with domestic, farm and other appliances and machinery driven electrically.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

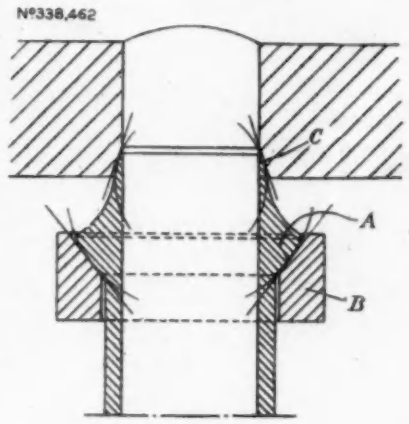
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

338,462. February 18th, 1930.—TUBE JOINTS FOR SUPERHEATERS, *The Superheater Company, Ltd., Bush House, Aldwych, London, W.C. 2.*

This invention is concerned with the jointing of superheater tubes into their headers. The tube is provided with a spherically formed protuberance A, which engages a clamp B with a

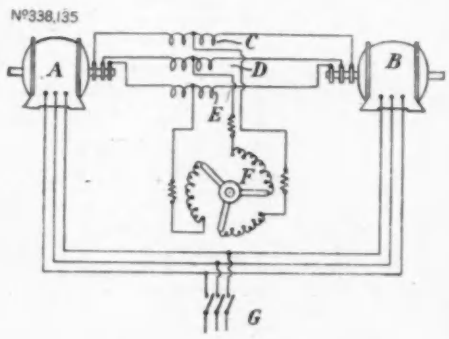


conical bore. The end of the tube is thinned down to a spherical end C, which is forced by the clamping action into the conical entry of the hole in the tube plate. It would appear that one of the essential features of the invention is the reduction in the thickness of the tube at its end, to allow it to adapt itself to the contour of the hole.—*November 20th*, 1930.

DYNAMOS AND MOTORS.

338,135. August 9th, 1929.—METHODS OF ELECTRICALLY COUPLING TOGETHER A.C. ELECTRICAL APPARATUS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Eric Harry Burnage Martin, of 88, Murray-road, Rugby.

This invention relates to the method of coupling the secondaries of two induction motors for running in synchronism from a common source. The corresponding secondary leads from each motor are coupled together through an inductance winding, and the common variable resistance is connected to the mid point of each of the inductance windings. Hence, if equal currents flow through two halves of an inductance winding to the variable resistance, there will be no resultant flux in the inductance core and therefore no inductive drop. If, however, a circulating current tends to flow from the secondary of one



motor to the other, such current will flow through the whole of the inductance winding and will set up a flux which will generate an E.M.F. opposing the flow of the circulating current and therefore serving to limit it to a safe value. Thus, by means of this invention, a good secondary power factor and starting torque for the two motors are claimed, since no inductance is introduced into the secondary circuit, unless the motors tend to fall out of step and synchronising currents flow. The two motors A and B have their rotor windings connected to the usual slip rings and the corresponding slip rings of each motor are connected to opposite ends of the inductance windings C, D, and E respectively, the mid point of each inductance winding being connected to the common variable resistance F. As shown, the stators of the two motors are supplied from a common source of current G.—*November 10th*, 1930.

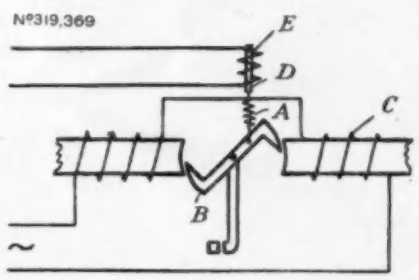
SWITCHGEAR.

318,636. September 6th, 1929.—ELECTRIC SWITCHES, *International General Electric Company, Inc., of 120, Broadway, New York.*

In the case of electric switches, to the contacts of which a current of gas under pressure is conducted in order to blow out the arc, the danger of resumption of the arc is overcome with only a relatively small distance apart of the contacts, on account of the great breakdown strength of the gas when under pressure. If the current of compressed gas is cut off after the conclusion of the switching process, then air under atmospheric pressure arises between the contacts. On account of the relatively slight dielectric strength of this air, the contacts must be much further separated from one another. According to the invention, the switch is so formed that even when there is no flow of compressed gas, excess pressure can be maintained on the contacts, and this excess pressure is allowed to continue even when the switch contacts are separated. With the excess pressure maintained with the switch contacts closed, all distances between parts of different potential can be kept smaller. The invention can be carried out by providing a switch with a contact through which gas may pass and a covering contact forming a gas-tight enclosure when the switch is closed. When the switch opens, the gas issues between the two contacts into and through an enclosing chamber until a closing piece, preferably of insulating material, actuated by the movable contact, closes the exit for the gas from the chamber. The exit from the chamber may also be closed by a valve which is opened and closed with the opening and closing of the switch, so that the part of the covering contact beyond its gas-tight connection with the other contact also remains under pressure by leakage between the contacts when the switch is closed.—*November 20th*, 1930.

319,369. September 20th, 1929.—RELAYS FOR THE PROTECTION OF A.C. MACHINES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

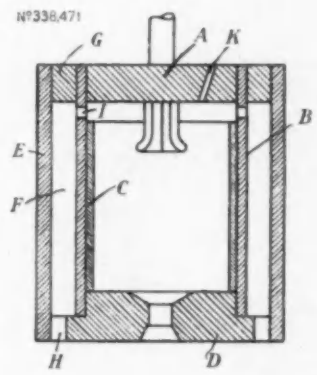
The relay described in this specification is intended for the protection of A.C. machines, and it is concluded that the operation of such relays should depend on the exciting current. In accordance with the invention, the exciting D.C. of the A.C. generator is allowed to act on the directional force of the relay



spring A. The armature B of the relay tends to rotate against the force of the spring by reason of the A.C. carried through the coil C and to be controlled. On the spring A there is an iron core D, which is acted upon by a coil E traversed by the energising D.C. Thus, with stronger energising currents the spring A will be more strongly tensioned, so that a stronger A.C. will also be necessary in order to bring the armature B into the position of release.—*November 20th*, 1930.

338,471. March 26th, 1930.—ELECTRIC OIL-BREAK SWITCHES, *International General Electric Company, Inc., of 120, Broadway, New York.*

This invention relates to electric oil-break switches in which there is attached to one of each pair of co-operating contacts an explosion chamber, the function of which is to confine the effects of the arc formed at the opening of the contacts to their neighbourhood and prevent it from striking the walls of the oil tank enclosing the contacts. A indicates a metal body, by means of which the explosion chamber is attached to the contact supporting conductor, B is a metallic jacket, which is attached to A and insulated with regard to the explosion chamber proper, by the hard-paper cylinder C. The explosion chamber is closed at



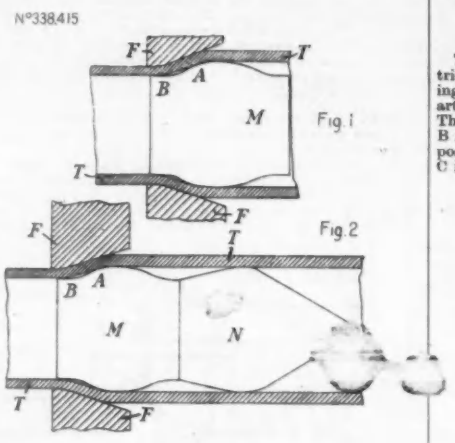
the bottom by a cover D, in which an aperture is provided for the passage of the co-operating contact. The explosion chamber has a further enclosing cylinder E of hard paper, which is spaced at F from the explosion chamber. The cylinder E is attached to the cylinder B by means of an intermediate ring G. The gases produced in the explosion chamber can pass in part through the openings I of the cylinder B into the hollow space F, and thence through the openings H into the oil tank. The aperture K in the metallic body A is provided for the purpose of allowing the gases remaining in the explosion chamber after the opening of the contacts to escape, thus permitting the explosion chamber to refil with oil from the enclosing tank of the contacts.—*November 20th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

338,415. December 24th, 1929.—APPARATUS FOR DRAWING METAL TUBES, Société Marcel Bassot et Cie., 14, Rue de Turenne, Paris, France.

This invention relates to apparatus for drawing tubes by the process in which a mandrel is fitted loosely in the tube and enters a drawing die through which the tube is drawn. Heretofore it has been proposed to use a mandrel having cylindrical surfaces which are in contact with the tube over a considerable length. This arrangement results in excessive friction and heating of the tube, and in possible fracture of it. According to the present invention, the mandrel and the die are of such shape that the tube is only in contact with the mandrel over a very small part of the length of the mandrel. By this means friction, heating, and the danger of tube fracture are, it is claimed, considerably reduced, and the speed of the drawing operation may be increased by suitably lubricating the working surfaces of contact between the mandrel and the tube. In Fig. 1 F designates the gauge plate, M the mandrel, and T the tube being drawn. As apparent from the drawing, the mandrel is of cylindrical shape, and has a spherical enlargement at an intermediate part of its length; there are two drawing surfaces A and B on the mandrel. In Fig. 2 there is disposed behind the drawing mandrel M a straightening mandrel N, so as to make the tube arrive normally over the mandrel M without any folding or deformation. The inventors say that they have found that in the manufacture of all tubes and more particularly in that of very long tubes of small diameters and thickness—for instance, that of tubes

having an outer diameter of 25 mm. and 5/10 mm. thick and below—deformations of the tubes may occur before arrival into the former, the tube remaining then no longer cylindrical [illegible] parts. These deformations occur chiefly whilst it is [illegible] and during the operations of annealing, scouring, o[illegible]. If the tube thus deformed is drawn with the main mand[illegible]e, a breaking of the tube may occur at the point where the tube is held fast between the mandrel and the former. In order to avoid this breaking, they dispose against the main

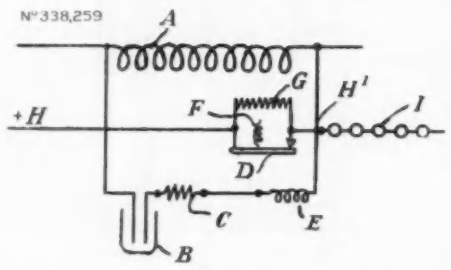


drawing mandrel M the straightening mandrel N the diameter of the base circumference of which is equal to that of the mandrel M and the larger diameter of which is equal to the inner diameter of the tube to be drawn. During the drawing operation the straightening mandrel N is held against the drawing mandrel by the deformations which may exist on the tube. It is urged to bear against this working mandrel M to restore the deformed tube into its cylindrical shape, so that the tube is perfectly gauged between the mandrel M and the gauge plate former F.—*November 20th*, 1930.

MOTOR CARS AND ROAD TRAFFIC.

338,259. September 9th, 1929.—CONTROLLING REGENERATION IN ELECTRICALLY PROPELLED VEHICLES, William Arthur Stevens, of "Castlemaine," London-road, Maidstone, Kent.

This invention relates to the control of compound-wound dynamo-electric machines of the kind used for the propulsion of vehicles, which will absorb electrical energy when acting as motors, but when the vehicles are descending steep hills or are being retarded on the level, will act as electric generators, and which, when the electro-motive force then set up exceeds that of the current supply line or battery, can be used to return current to such source of current supply, hereinafter referred to as the current supply line. The automatic shunting of the series field winding A of the dynamo-electric machine when it is acting as a generator is effected by means of a Nodon valve B or equivalent device. This valve has a resistance C in series with it, and the combination is connected in shunt with the series field winding in such a way that, when the direction of the current through the series field winding causes it to act cumulatively with the shunt winding, *i.e.*, when the machine is acting as a motor, practically no current can pass through the Nodon valve, but when the current through the series field winding is

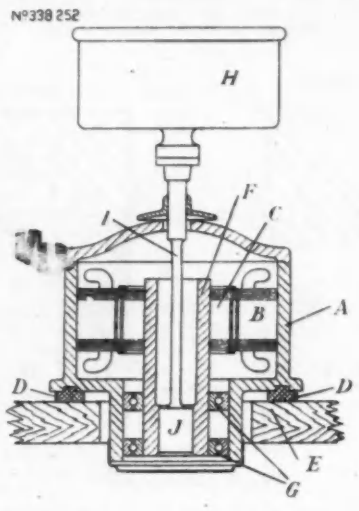


in the other direction and the machine is regenerating, the current follows two paths, one through the series field winding and the other through the Nodon valve with its resistance C in series, and the latter will form a shunt to the series field winding, the amount by which the series field winding is shunted being controlled by the amount of resistance in series with the Nodon valve or its equivalent. It will be seen that with this arrangement the series field will not be shunted when the machine is motoring, but will be automatically shunted when the machine is generating, thus reducing the number of effective turns in the series field and therefore its demagnetising effect. To safeguard the lighting system of the vehicle against excessive voltage, when the machine is regenerating strongly, an electrically operated switch D is provided, the winding E of which may be connected either in series, or in shunt, with the Nodon valve. In the former case this switch is normally closed by a spring F, but will be opened when current passes through its winding E. When closed, it will short-circuit a resistance G in series with the lighting circuit H H¹. It will be in this position when the prime mover is motoring, as, in that case, the Nodon valve will pass practically no current. When the machine is acting as a generator, the Nodon valve will pass a heavy current, which, traversing the winding of the electrically operated switch D, will cause it to open, removing the short-circuit from the resistance G in series with the lighting circuit H H¹, and thus preventing an undue rise in voltage across the lamps I.—*November 20th*, 1930.

MISCELLANEOUS.

338,252. September 3rd, 1929.—ELECTRIC INDIVIDUAL DRIVE FOR HIGH-SPEED REVOLVING BODIES WITH VERTICAL SPINDLES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany, and Hans Dietzius, of Berlin-Pichelsdorf, Germany.

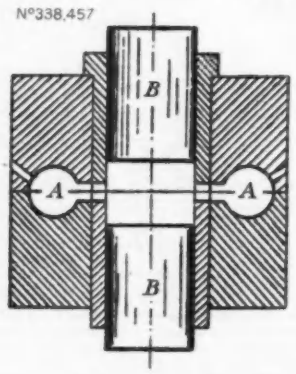
This invention has for its object a construction of an electrical individual drive specially adapted for high-speed revolving bodies with vertical spindles, in particular for the drive of artificial silk spinning cans, doubling spindles, and the like. The housing A of the driving motor, consisting of the stator B and the rotor C, is supported on the solid base E, with interposed elastic means, as, for example, rubber buffers D. The rotor C is fitted on the hollow shaft F, which is only carried in the



roller bearing G underneath the rotor. The spindle I, carrying the spinning can H, passes freely through the hollow shaft F to permit of deflection therein, and is provided at its lower end with an enlarged portion J by which it is secured to the lower end of the hollow shaft. The balance drive runs exceptionally smoothly, and can be driven at any speed desirable. It has been shown that the drive is not sensitive to considerable out of balance. A further advantage is that even at the highest speeds and with large out of balance the bearing is scarcely strained. The arrangement of the bearing permits of a simple and reliable lubrication. The bearing and all the other parts of the new drive are also easily accessible, so that the gear can be easily attended to.—*November 20th*, 1930.

338,457. February 13th, 1930.—A METHOD OF WORKING PURE FUSED SILICA, Quarts et Silice, 8, Rue d'Anjou, Paris.

This invention may not be directly of interest to engineers, but is noteworthy for the appliances and processes employed. It is concerned with the production of articles from fused silica, but their ultimate service is not indicated. It is explained that a block of fused pure silica, softened at very high temperature, then squeezed rapidly between the platens of a press, gives a kind of flat cake, upon which the applicants for patent rights have observed the following peculiarities:—(1) The surfaces are cracked in the neighbourhood of the centre, while the periphery presents no cracks; (2) the bubbles or flaws which existed in the block are found again in the centre of the flat cake, but the peripheral regions do not contain any. If the block subjected to squeezing is made of opaque silica, the flat cake obtained is



more transparent at the edges than at the centre. From these observations, it can be deduced that the soundest parts of the articles, both as material and as surface, are those which have been given while hot a rapid displacement parallel with the plane of the platens. Based upon these remarks, the present invention, which is due to Monsieur Henri George, has for its object a process of moulding under pressure pure silica or any other vitreous material which is fusible with difficulty. It consists—(1) in a first operation, in carrying a block of fused silica to a very high temperature of the order of 2000 deg.; (2) in a second operation, in squeezing the material while hot between two pistons moving rapidly in a cylinder, in such a way as to drive it into cavities or moulding spaces, situated at the periphery of the cylinder and communicating with the interior by way of suitable orifices. The accompanying drawing represents in a diagrammatic manner, in section, this second operation, in which the moulding spaces are shown at A A and the two pistons at B B.—*November 10th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TUESDAY, DECEMBER 30TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. I., Some Properties of Electrified Bodies," by Professor A. M. Tyndall. 3 p.m.

1931.

THURSDAY, JANUARY 1ST.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. II., The Spark as a Current of Electricity," by Professor A. M. Tyndall. 3 p.m.

FRIDAY, JANUARY 2ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Extra general meeting. "An Experimental Investigation into Induction Conditions, Distribution, and Turbulence in Petrol Engines," by Mr. S. J. Davies. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "Weighing Machinery," by Mr. W. A. Benton. Illustrated by slides and exhibits. 7.30 p.m.

SATURDAY, JANUARY 3RD.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. III., Air as a Conductor of Electricity," by Professor A. M. Tyndall. 3 p.m.

TUESDAY, JANUARY 6TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. IV., The Mechanism of a Spark and Other Forms of Discharge," by Professor A. M. Tyndall. 3 p.m.

THURSDAY, JANUARY 8TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The Merchant Venturers' Technical College, Unity-street, Bristol. "Light Alloy Piston Development," by Mr. E. V. Pannell. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. Ordinary Meeting. An oil painting of Graham Bell will be presented to the Institution by Sir Hugo Hirst, Bart. The portrait is by Mr. W. W. Russell, R.A. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting of the Northern Irish District at Town Hall, Main-street, Bangor, 2 p.m. A paper and discussion on "Urban Works," by Mr. G. H. Fleming. 3 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. V., Some Properties of Sparks and Arcs," by Professor A. M. Tyndall. 3 p.m.

FRIDAY, JANUARY 9TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Monel Metal: Some Notes on its Production and Industrial Application," by Mr. J. Doonan. 7.30 p.m.

SATURDAY, JANUARY 10TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—At the Grand Hotel, Manchester. Annual dinner. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lectures: "The Electric Spark: No. VI., Large Sparks," by Professor A. M. Tyndall. 3 p.m.

MONDAY, JANUARY 12TH.

ILLUMINATING ENGINEERING SOCIETY.—By invitation of the British Commercial Gas Association, in the Board Room at 28, Grosvenor-gardens, Victoria, S.W. 1. "Recent Developments in Gas Lighting," by Mr. E. L. Oughton. 7 p.m.

WEDNESDAY, JANUARY 14TH.

INSTITUTION OF CHEMICAL ENGINEERS.—At Burlington House, Piccadilly, London, W. 1. "The Concentration of Phosphoric Acid Solutions by Means of a Submerged Flame," by Mr. C. Featherstone Hammond. 8 p.m.

FRIDAY, JANUARY 16TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Some Problems Surrounding the Reorganisation of an Engineering Works," by Mr. K. W. Willans. 7.30 p.m.

NATIONAL CONFERENCE ON INDUSTRIAL MECHANISATION.—Hotel Metropole, London, W.C. 2.

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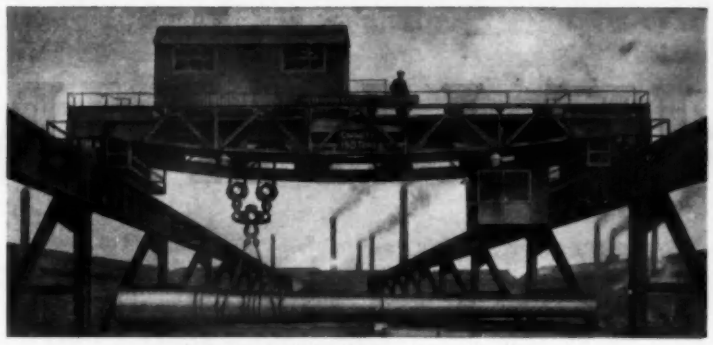
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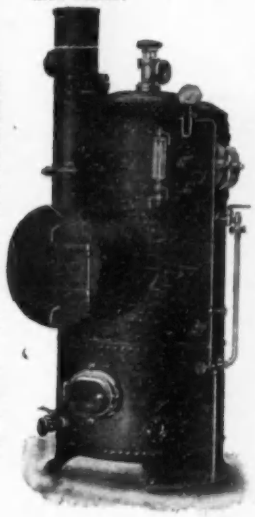
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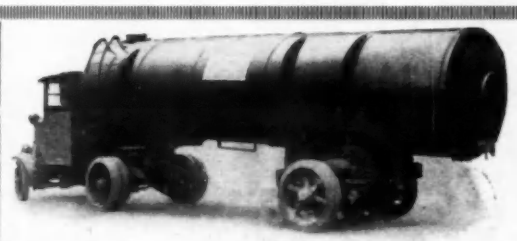
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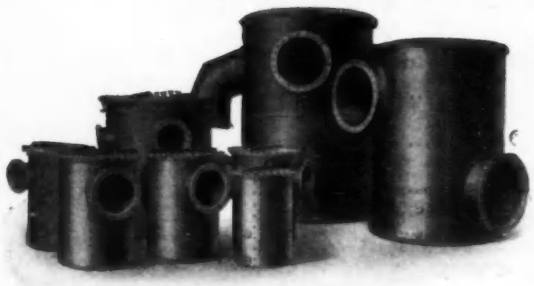
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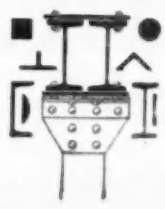

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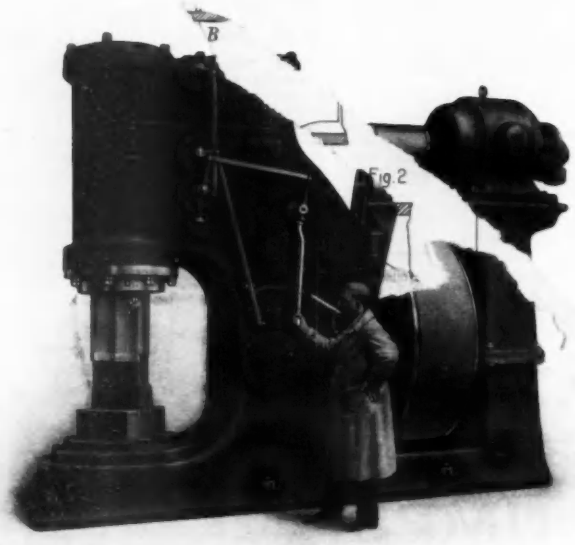

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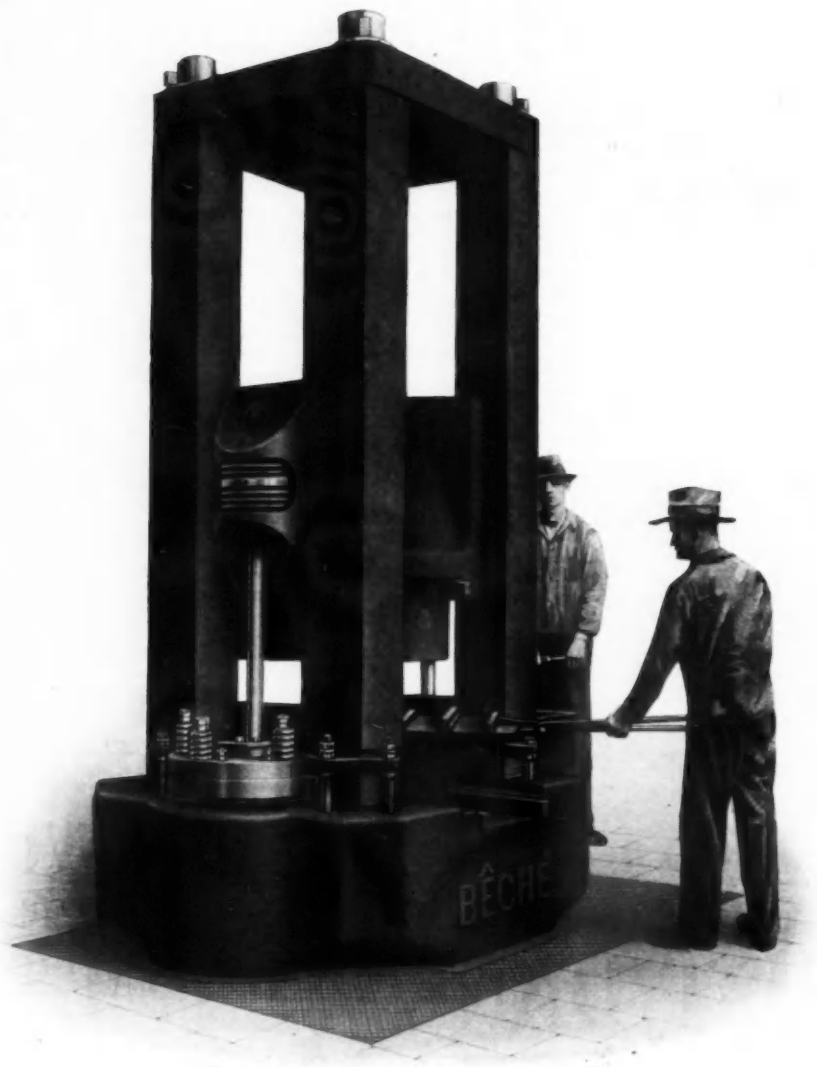

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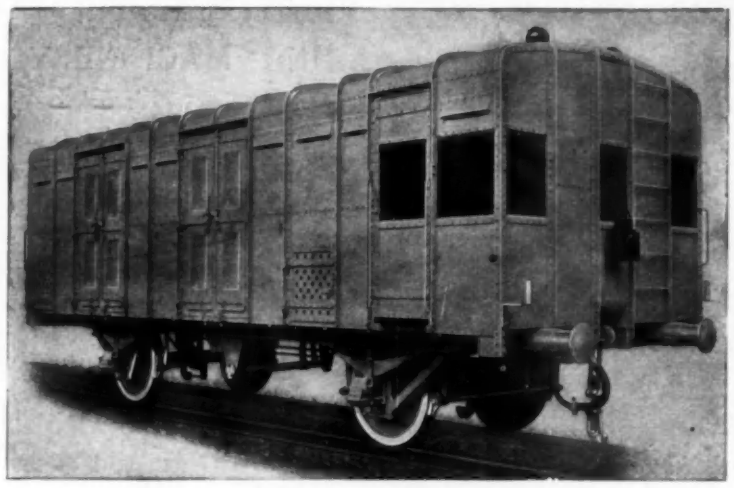

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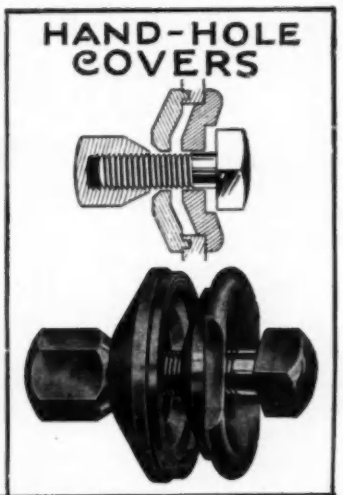

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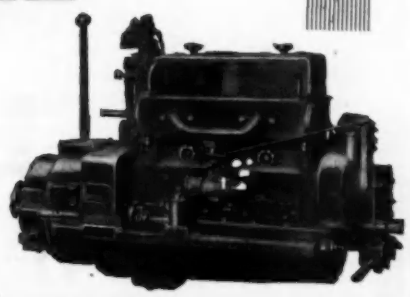

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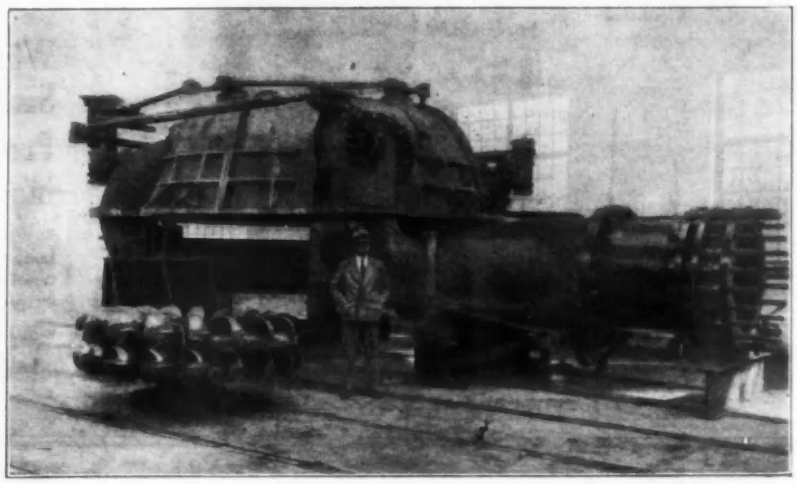

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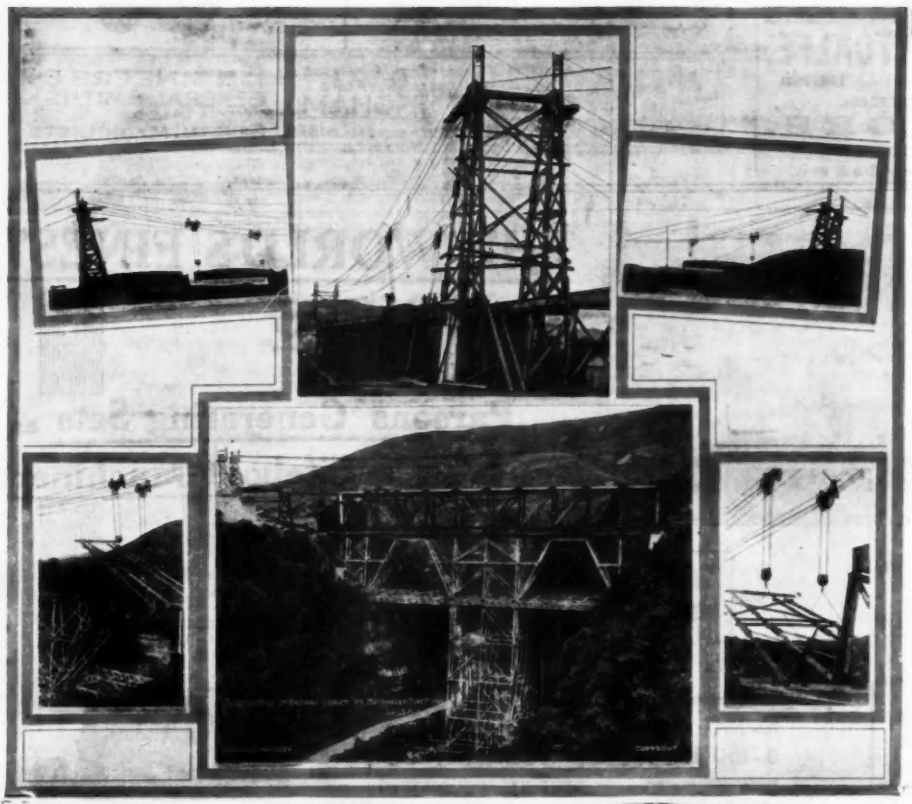

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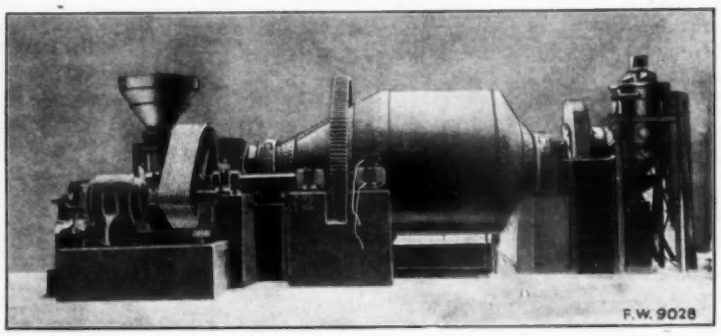

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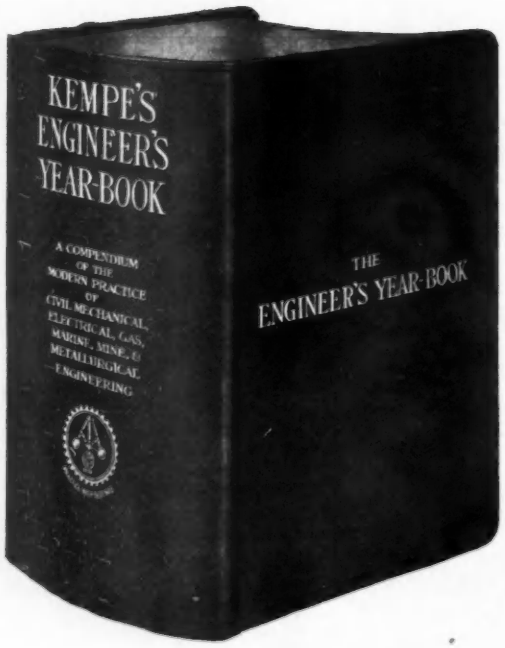

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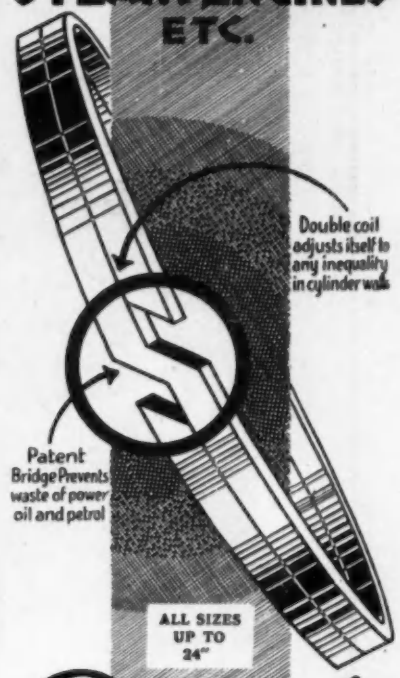
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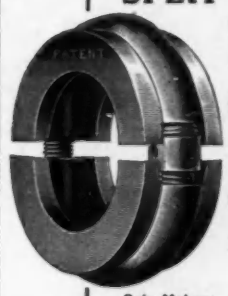

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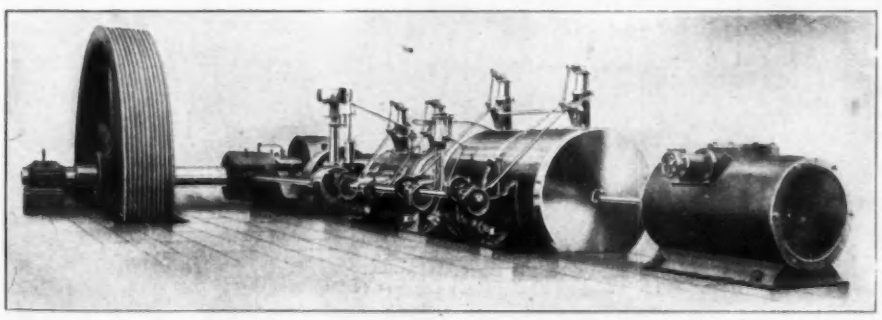

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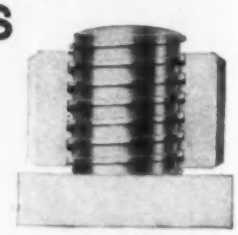
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THE METALLIC MANUFACTURING Co LTD

Ardrossan Ayrshire

TELEPHONE No. ARDROSSAN

CONTRACTORS TO ADMIRALTY AND GOVERNMENT DEPARTMENTS.

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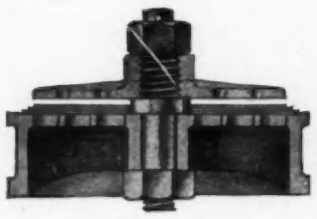

METALLIC DISC VALVES.

MANUFACTURERS OF

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Multiplex dead-lift or Flexible types. For Air, Circulating, Hydraulic, Feed, &c., Pumps. Easily fitted to existing Pumps.

Supplied to over 300 Warships of the British Navy.

CORRUGATED METALLIC JOINTS

Made of Brass, Copper, Nickel, Monel Metal, Steel, &c. Of any shape or size. For Steam, Hydraulic, Oil or Blast Pipe Joints.

SEAMLESS COPPER JOINT RINGS

Soft annealed. Of all sizes, shapes and sections.

COPPER-and-ASBESTOS JOINTS AND WASHERS

For Steam and Water Pipe Joints. Motor Car, Diesel and Aero Engines.

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For Glands of all types of Steam Engines. Suitable for High or Low Pressures.

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For Jointing Gas or Water Cast Iron and Steel Mains.

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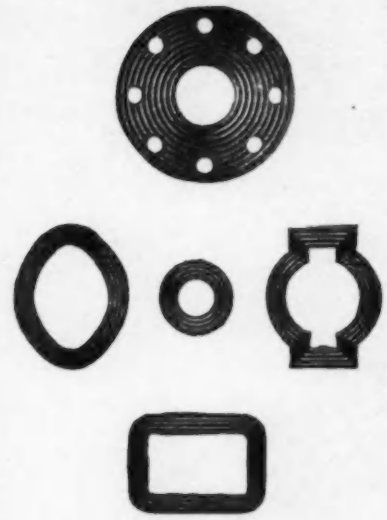
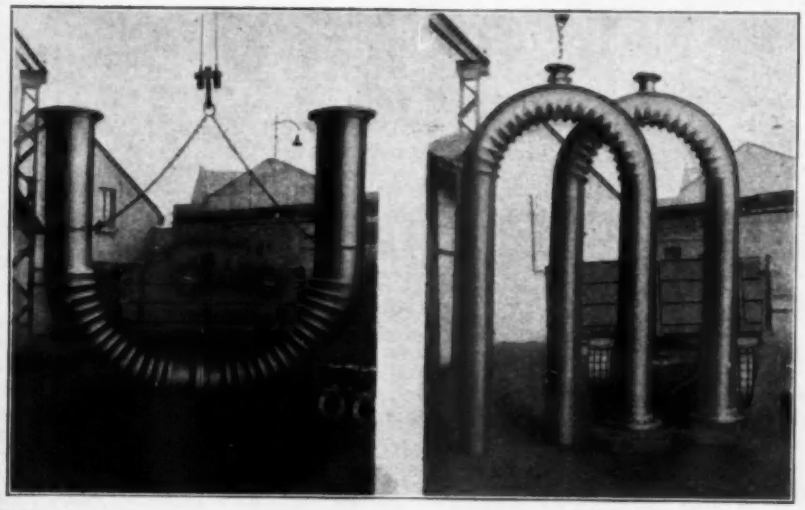
For Steam, Water or Gas Joints. Specially suitable for use in conjunction with Corrugated Metallic Jointing.

Illustrated Catalogue on application.



CORRUGATED METALLIC JOINTS.

THE NEEDS OF PROGRESS



The photograph shows 18" & 14" bore Creased Return Bends.

Progress in modern industry continually calls for improvements in the materials used; so in steam practice the high pressures and temperatures of to-day demand of pipes strength, reliability and the power to withstand long, continuous use under arduous conditions.

Aiton's pipes have for many years maintained a reputation for reliability and efficiency; their designs will deal with any conditions arising in steam practice, and their construction will defy the hardest service.

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ENSURE
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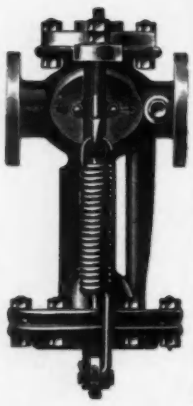

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Where others melt or split up Glenboig stands.

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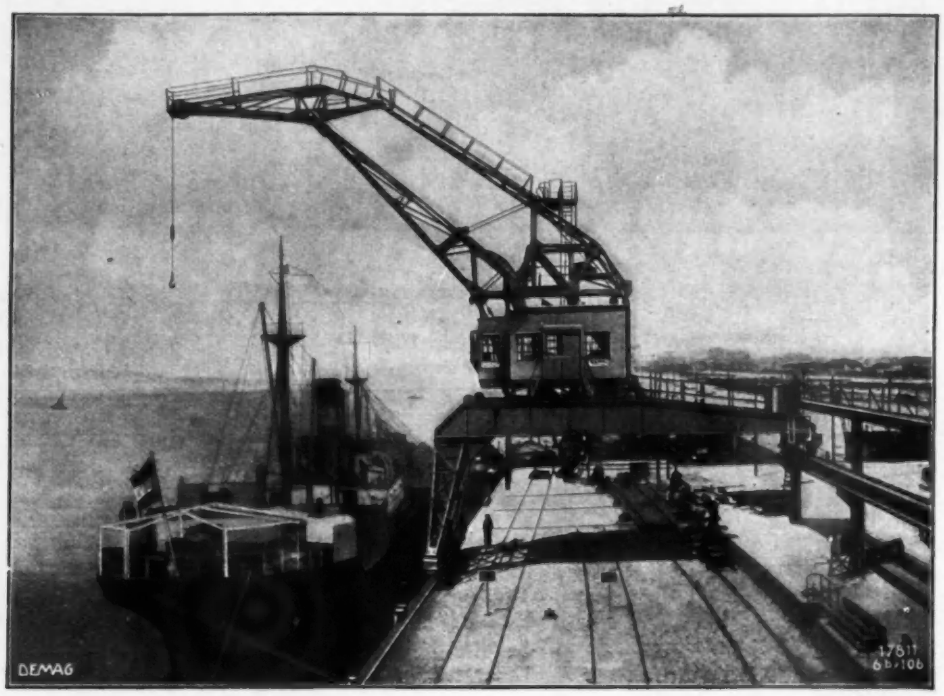

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NETHERTON IRONWORKS, KILMARNOCK. Telegrams:-BARR KILMARNOCK Telephone:- 791 (Two Lines)

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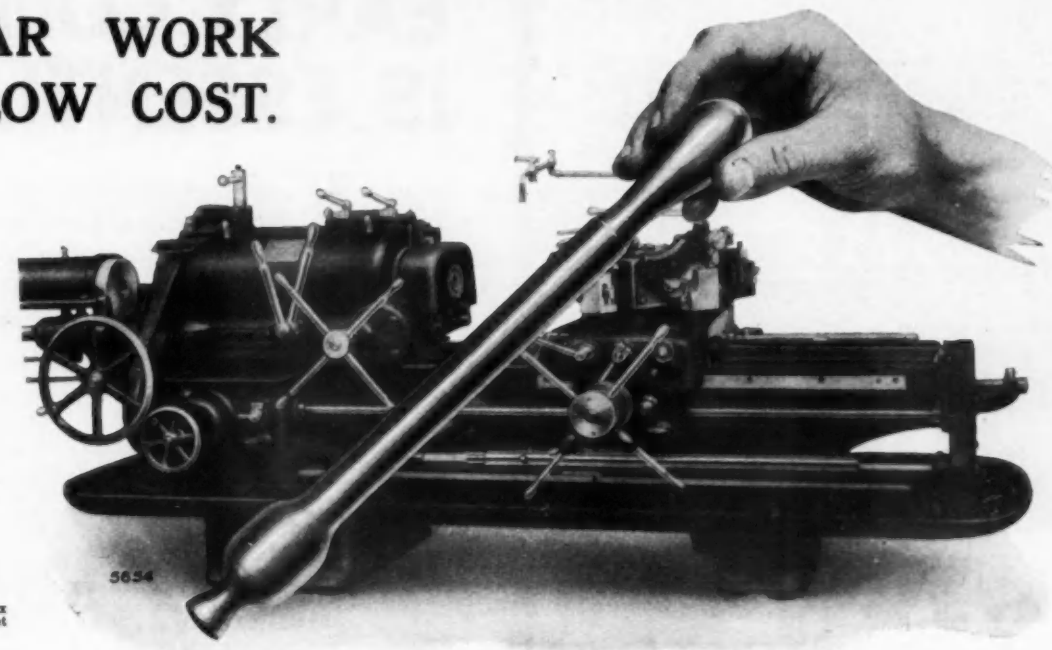
STEEL EMBOSSED MANHOLE DOORS, FLANGES, PISTONS, WELDLESS STANDPIPES.
ALL KINDS OF—
PRESSINGS & FORGINGS

HERBERT

FOR BAR WORK AT LOW COST.



This lever is produced in one operation in six minutes on a Herbert No. 13 Hexagon Turret Lathe. Material 1¼" M.S. Bar.

HERBERT Hexagon Turret Lathes have anti-friction bearings and covered beds.
These, in conjunction with Roller Steady Turning Tools, enable the new high speed cutting alloys to be used to best advantage. Heavy reductions in diameter can be made in one cut. Alignment is practically everlasting. Depreciation and maintenance costs are very low.

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We also make a smaller size with ordinary bed and plain bearing spindle—No. 1 ... 1⅝" × 27" **DELIVERY.**

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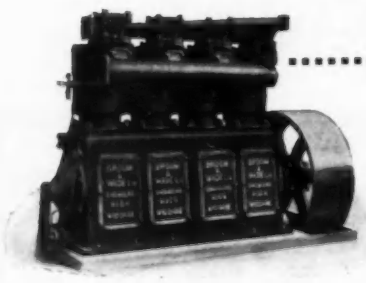
"BROOMWADE" Air Compressors

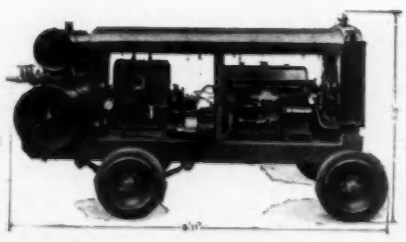
BRITISH MADE.



"BROOMWADE" COMPRESSED AIR EQUIPMENT has a Sterling Reputation for Efficiency and Reliability wherever compressed air is used. On land and sea, in all parts of the world, this reputation is being daily extended, and our works—the most modern and probably the largest of their kind in this country—together with an organisation built up during nearly **30** years' specialised experience, is at your service.

Reciprocating and Rotary Compressors, Stationary or Portable Types to suit all duties.

Catalogues and other information on request.



BROOM & WADE LTD. HIGH WYCOMBE.

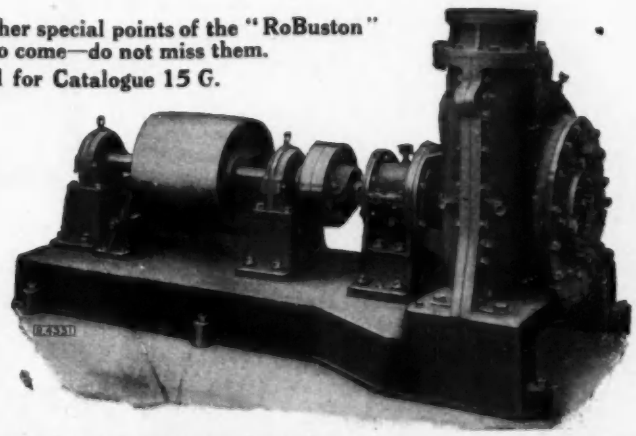
RoBuston
REGISTERED TRADE MARK

Gravel Pump

RENEWAL COSTS are very low, and necessary replacements are made easily and quickly. The pump shaft is fitted with a specially hardened steel bush which is renewable at very small cost. As the replacement of such an expensive item as a complete shaft is unnecessary, a great saving is made.

The main shaft is made in two parts so that the pulley end of the shaft need not be disturbed and the whole operation of replacing a worn impeller occupies only a FEW HOURS. These features indicate that in the "RoBuston" renewal costs and the loss of working time have been REDUCED TO A MINIMUM.

Further special points of the "RoBuston" yet to come—do not miss them.
Send for Catalogue 15 G.



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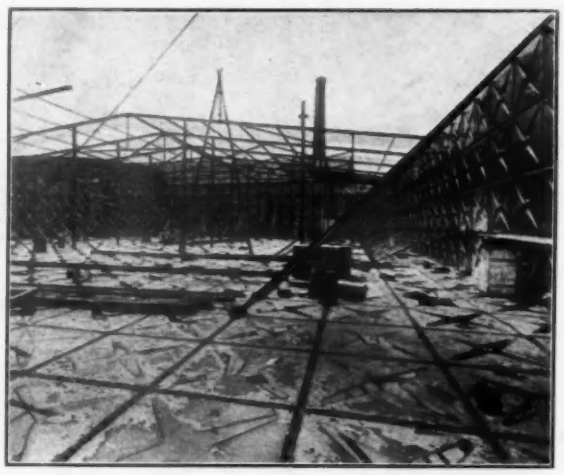
FIRST STAGE



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"We must stipulate that EARLY COMPLETION IS ESSENTIAL..."

IF the time factor is important, Braithwaite Tanks are the proved choice when tanks are required. The photographs shown demonstrate graphically that Braithwaite's make short work of erecting even the largest capacity tank.

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Braithwaite's have hundreds of thousands of these plates in stock; from them are built up tanks of any capacity—2½ million gallons down to 220 gallons—in the shortest time. Easy to erect, simple to maintain, either on steel towers or at ground level; the capacity can be arranged so that it can be enlarged if required.

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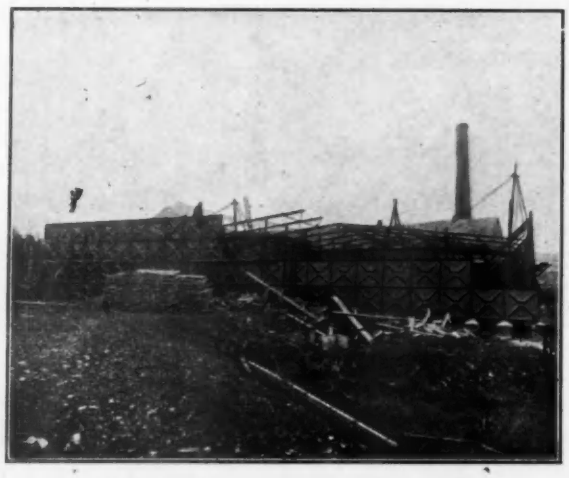
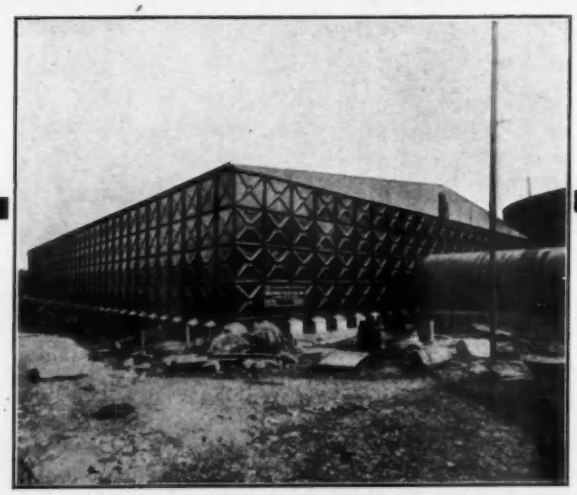
Telephone: Victoria 8573. Telegrams: "Bromkirk, Phone, London."

BRAITHWAITE



AFTER 39 DAYS

STEEL
STRENGTH
SECURITY



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CAPSTAN AND Ward TURRET LATHES

ARE BUILT IN LARGE BATCHES TO JIGS AND GAUGES WHICH ENSURE INTER-CHANGEABILITY, AND DELIVERY OF NEARLY ALL SIZES CAN BE OBTAINED

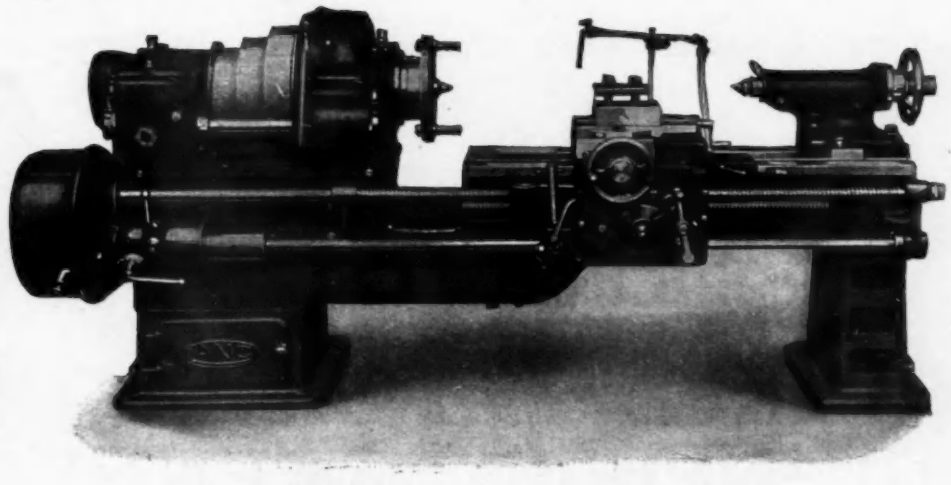
FROM STOCK

A cordial invitation to visit our works is extended to all engineers interested in the economical increase of production.

H. W. WARD & Co. LTD., DALE ROAD, SELLY OAK, BIRMINGHAM.

LANG for LATHES

In general construction this lathe follows the well-proved Lang Standard Lathe, but embodies a new Friction Headstock having 3 gear ratios and 3-step cone pulley. Quick withdrawal motion is also provided, and four automatic knock-off stops serve the sliding, surfacing and feed motions.



8¼ INCH CENTRE FRICTION CONE HEADSTOCK LATHE WITH 3¾ INCH HOLLOW SPINDLE.

Full descriptive Literature of the famous "Lang" range of Sliding, Surfacing and Screw-cutting; Surfacing and Boring; Brass Finishing Lathes; Gear Tooth Rounding Machines will be sent on request.

— JOHN LANG & SONS, LTD., JOHNSTONE. —

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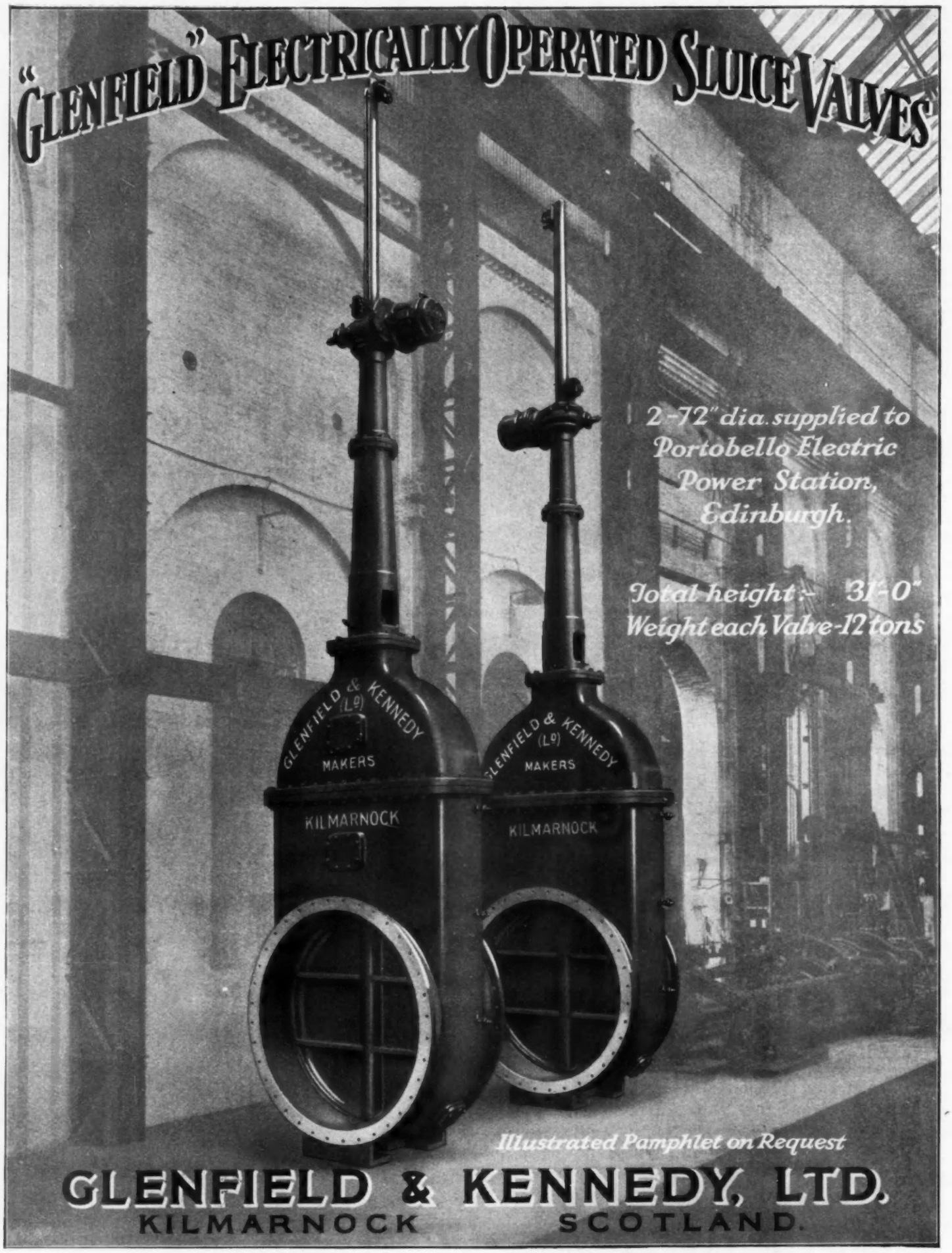
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2-72" dia. supplied to Portobello Electric Power Station, Edinburgh.
Total height :- 31-0"
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GLENFIELD & KENNEDY (Lº)
MAKERS
KILMARNOCK
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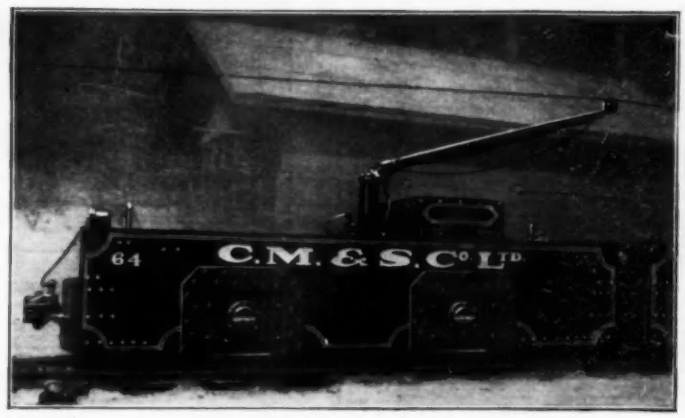
Increasing tractive power

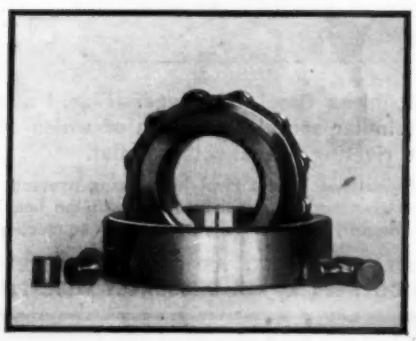
When the Consolidated Mining & Smelting Company of Canada Ltd. wished to bring up the weight of their mine locomotives from 9½ tons to 13½ tons (retaining the original motors) in order to increase their tractive power, they were faced with the difficulty that if the greater weight prevented the wheels from slipping when full power was suddenly applied, the armatures would probably burn out. The solution was to reduce all friction to the minimum except between tyres and rails. This was accomplished by fitting



This indicates one only of the many advantages of Hoffmann Roller Bearings as applied to axle boxes. We shall be pleased to give you an outline of the benefits you may expect from their use. Please send us full particulars of the conditions obtaining.

Hoffmann Roller Bearings

THE
HOFFMANN
MFG. CO. LTD.
CHELMSFORD,
ESSEX.



to the axle boxes. Not only was the anticipated trouble averted, but power has been saved both in starting and running, and in the ability to coast over long stretches. The owners express themselves as being very pleased indeed with the results.

C

CLARKSON
Silencer
BOILERS

Greatest performance for size—7 lbs. evaporation per sq. ft. of heating surface from Diesel exhaust gases.

NO TUBE TROUBLES.
NO PRIMING. NO SCALING
Most accessible for cleaning.

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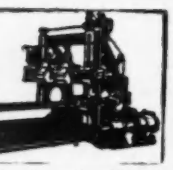

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STEEL PLATE CONSTRUCTIONS
CHEMICAL PLANT IN ACID RESISTING STEELS
CAST IRON WORK OF ANY TYPE.
GAS PRODUCERS
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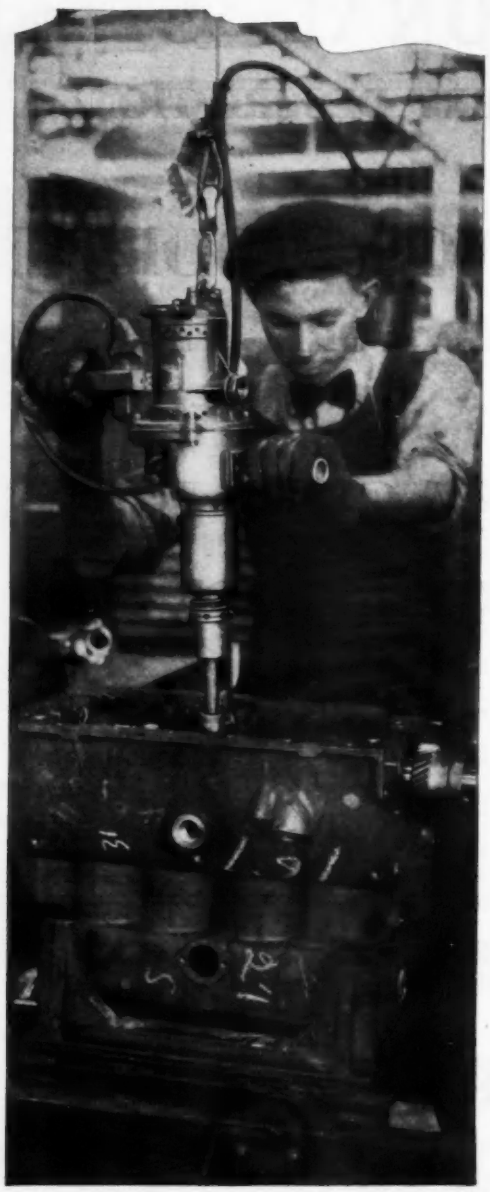
STOCKTON-ON-TEES.

Creating a *New Standard of* Portable Tool Efficiency



Thor HIGH FREQUENCY ELECTRIC TOOLS
Make Possible Startling Production Advantages

The three outstanding advantages of Thor High Frequency Electric Tools are:—

1. Constant Rate of Speed.
2. Simplified Construction.
3. Light Weight.

Advantage No. 1 (Constant Rate of Speed) offers tremendous possibilities in increasing production. Each operator's output is increased several times with no strain on man or machine.

Advantage No. 2 (Simplified Construction) eliminates the use of commutator and brushes which have caused trouble in most Universal motor tools. This new and improved construction does away with the frequent servicing heretofore necessary.

Advantage No. 3 (Light Weight) results in easier handling by workmen, assuring greater efficiency. This feature also makes possible the use of only one man on heavier jobs, which heretofore always required two men because of the size and weight of the machine used.

No matter what the operation—drilling, reaming, tapping, screw driving, nut driving, stud setting, grinding, sanding—it can be accomplished more quickly and efficiently with Thor High Frequency Tools than ever before.

Many plants will testify to the great savings effected with these new tools. Investigate their possibilities. Learn what they are doing for others and what they can do for you. Complete information is yours for the asking.

We also manufacture a complete line of Universal Electric and Pneumatic Tools. Literature sent willingly on request.

TOOLMAKERS SINCE 1893.

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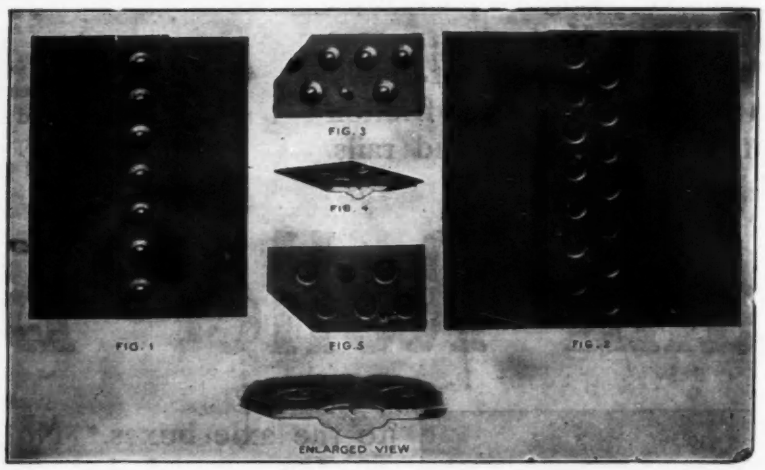
40, BROADWAY, WESTMINSTER, LONDON, S.W.1.
Telephone: Victoria 6055. Telegrams: "Thortool," Sowest, London. Cables: "Thortool," London.



DE BERGUE & Co., Ltd.
MANCHESTER.

NEW PATENT RIVETING PROCESS FOR ALL SHEET METALS.

British Patent No. 323,446.
Foreign Patents Pending.

The illustration shews samples in Stainless Steel 20 gauge. Figs. 1 and 2 shew the back and front faces. Figs. 3, 4 and 5 shew similar samples, in each of which one rivet is not finished. Before riveting, the sheets are flat.

The countersunk effect is obtained by the original special flat rivet head being pressed flat into the sheets, causing them to sink into a cupped depression in the riveting tool simultaneously with the heading of the rivet. The shear stress is removed from the rivet shank, being taken by the interlocked sheets. A squeeze-type pneumatic riveter is used.

MORE THAN TWICE AS STRONG AS ORDINARY RIVETING.
GIVES PERFECT TIGHTNESS AT AN UNUSUALLY WIDE PITCH.

YARROW MARINE BOILERS

totalling over

30,000,000 SQ. FT. HEATING SURFACE

installed in

SEVERAL THOUSAND VESSELS

Over 3,000,000 Sq. Ft. Heating Surface

installed in

THE MERCANTILE MARINE
DURING THE LAST THREE YEARS ALONE

YARROW-GLASGOW

"GWYNNES"
CENTRIFUGAL PUMPS
AND
COMPLETE PUMPING INSTALLATIONS
STEAM, OIL OR ELECTRIC POWER

for

DRAINAGE,
IRRIGATION,
DOCKS,
MINES,
WATERWORKS,
HYDRAULIC POWER,
SEWAGE,
FIRE,
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SUCTION DREDGING,
BOILER FEEDING,
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AND ALL STANDARD & SPECIAL SERVICES FOR PUMPING WATER, OIL OR OTHER LIQUIDS.

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Telephone: Riverside 1910
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Hammersmith Works
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"K"
ORIGINAL SEAMLESS STEEL
SERRATED OILFEEDERS
KAYE'S

N.B. "The Serration mean Strength."

Pattern No. 320. ½ Pint.
Seamless Steel "Force-Feed" Type
Various Sizes.

Seamless Steel Oil Fillers.
Handle at Back or Side.
Sizes, 1 pint, 2 and 3 pint.

Pattern No. 39. 1 Gall.
Corrugated Steel Oil Bottles with Spout.
Sizes 2 Pints to 5 Gallons

OIL CABINETS
Complete with Pump.
Sizes 1 to 100 gallons.
"SAVE TIME & MAKE THE HANDLING OF OIL A PLEASURE."
Painted Red Enamel

Pattern No. 6. ½ Pint

Various Sizes.
Seamless Steel Valve Type.

Write for FREE CATALOGUE.
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Oilcan Works
LEEDS
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ESTABLISHED 1864

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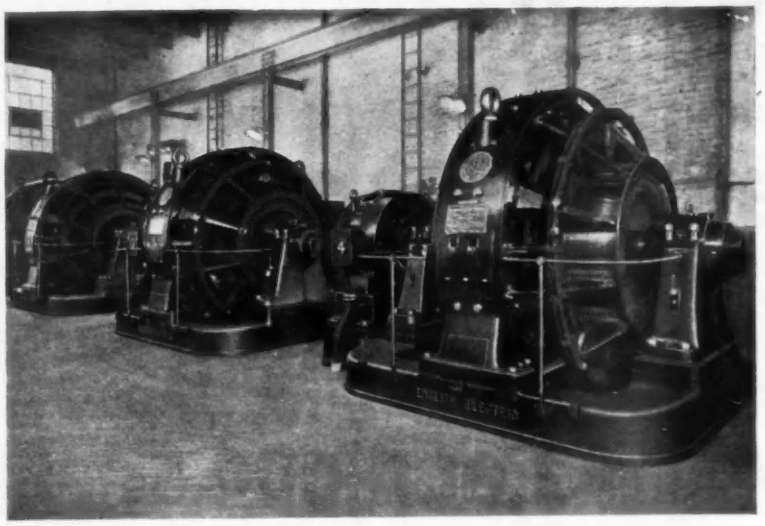
SPECIAL COATED ELECTRODES
FOR ARC WELDING
TYPES & QUALITIES FOR ALL PURPOSES
THE WHITECROSS COMPANY LTD
WARRINGTON ENGLAND

J.B. STONE & Co's
LTD.
NEW HEAVY TYPE
PATENT
NIBBLING MACHINE
for rapid cutting of sheet metal.
J.B. STONE & CO. LTD.
135, FINSBURY PAVEMENT,
LONDON
EC2

"English Electric"

View of three 2,000 k.W. Rotary Convertors in the **Mansion House Substation** *of the London Electric Railway.*



IN THE HEART OF THE EMPIRE

AUTOMATIC TRACTION SUBSTATION

View of Two 2,500 k.W. Rotary Convertors in the Russell Place Automatic Substation of the Melbourne City Council.

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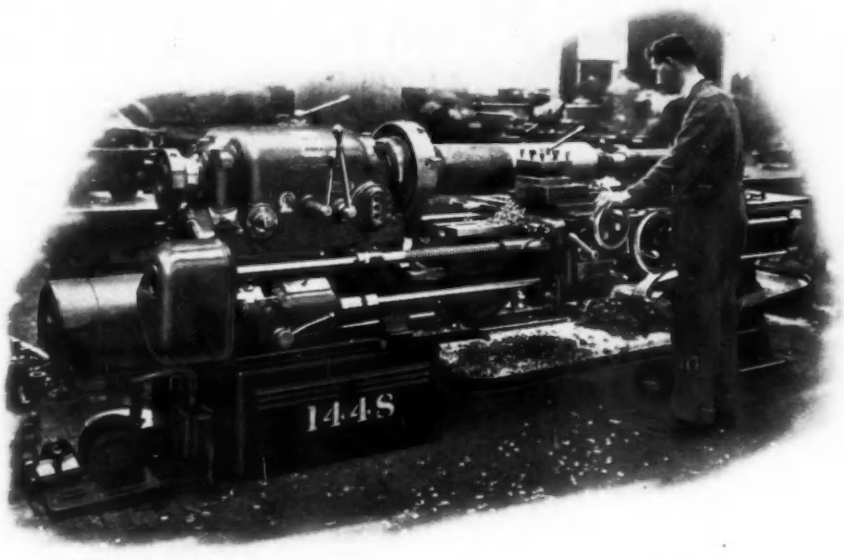
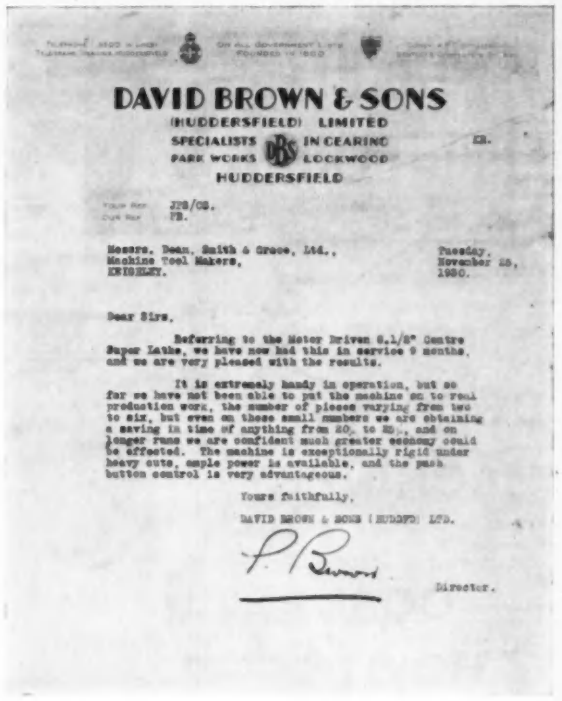


Photo. by courtesy of Messrs. David Brown & Sons (Hudd.), Ltd.



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Machine Tool Makers,
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Referring to the Motor Driven 6.1/2" Centre Super Lathe, we have now had this in service 9 months, and we are very pleased with the results.

It is extremely handy in operation, but so far we have not been able to put the machine on to real production work, the number of pieces varying from two to six, but even on these small numbers we are obtaining a saving in time of anything from 20% to 30%, and on longer runs we are confident much greater economy could be effected. The machine is exceptionally rigid under heavy cuts, ample power is available, and the push button control is very advantageous.

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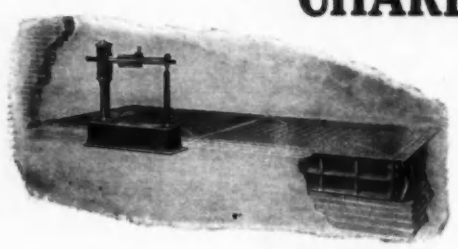

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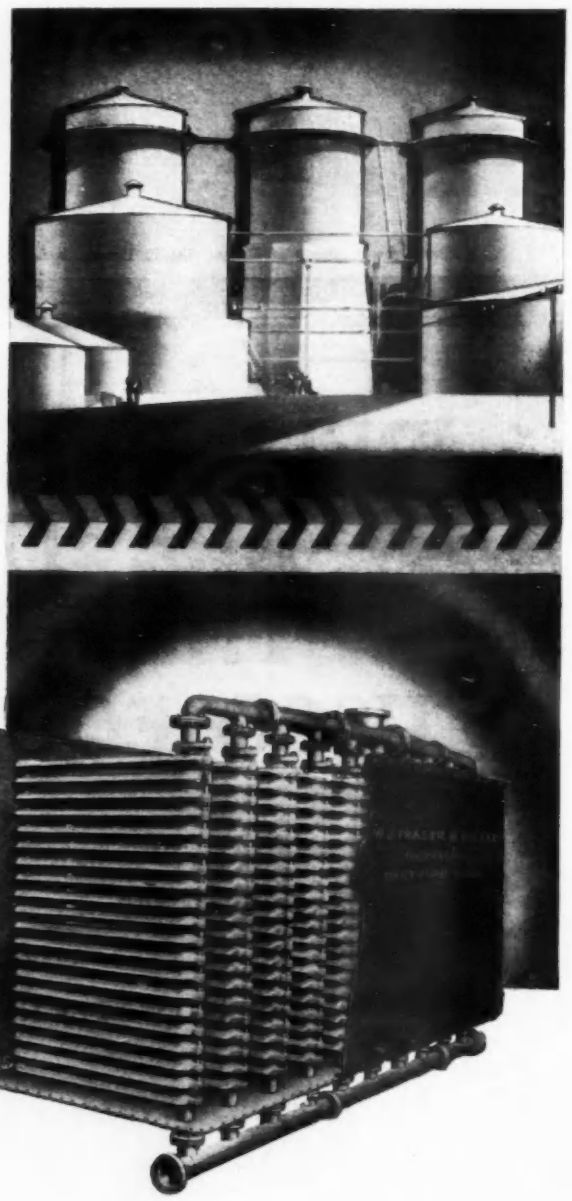

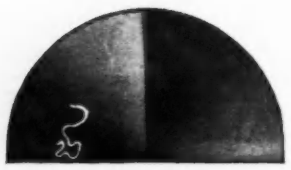

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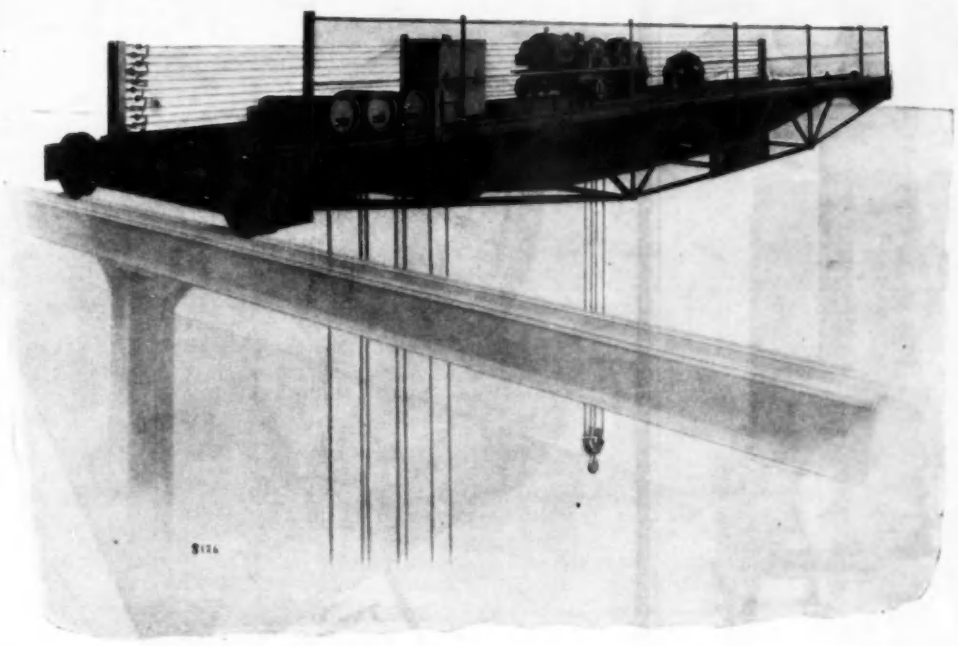

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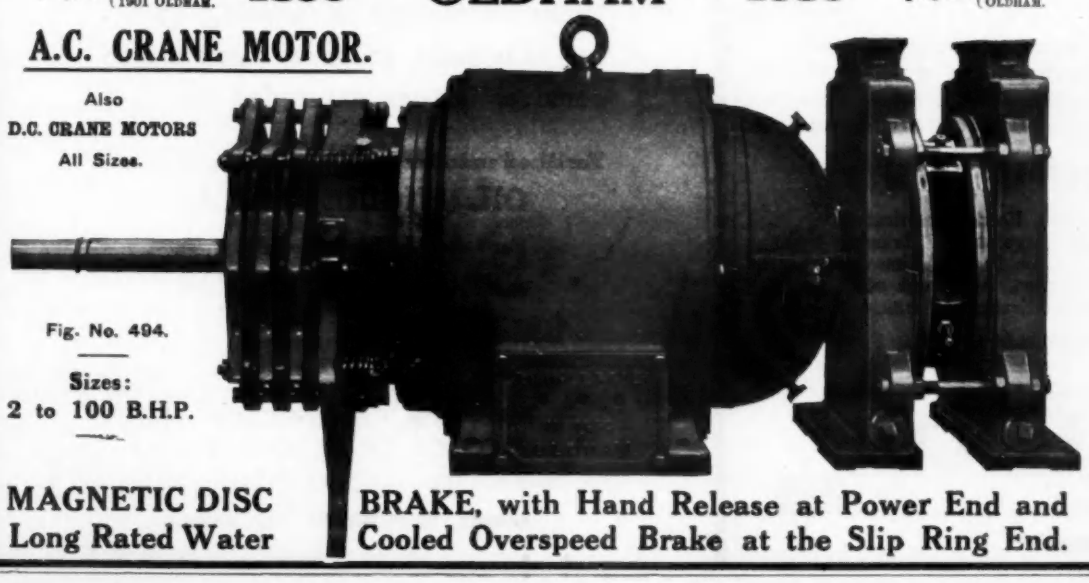

Fig. No. 494.

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WASTE OIL FILTERS

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YOUR DIRTIED OIL FILTERED AND RENDERED FIT FOR USE OVER AND OVER AGAIN.

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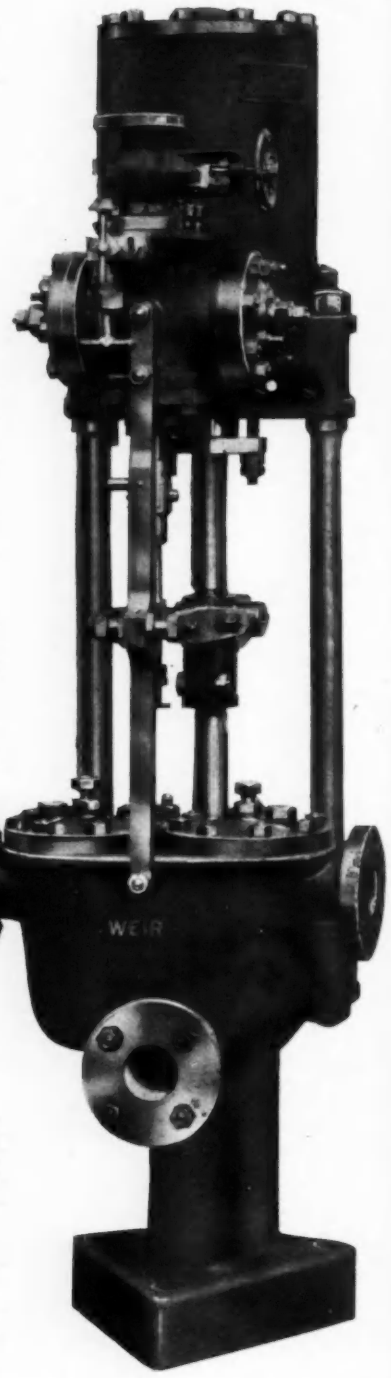
WEIR PUMPS

Illustrated is a Weir Direct-Acting Boiler Feed Pump. Built in standard sizes up to 21,500 gallons per hour.

Supplied to Leading Steamship Companies, Power Corporations and industrial establishments throughout the world.



ADVANTAGES :

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Specially suitable for feeding Water Tube Boilers.

Owing to the relatively small quantity of water in Water Tube Boilers, it is essential that the feed should be steady and uninterrupted. Weir Direct-Acting Feed Pumps, on account of their slow and regular movement, are unequalled for maintaining continuous steaming at any pressure, and are more extensively used than any other type for this important service. Special materials to resist corrosion, erosion and high temperatures are used for pump rods, valves, valve seats, etc. Weir "Triple H" quality ebonite pump rings are fitted. These are undamaged at 400°F., and possess special hard wearing qualities.

The Weir Range includes:

Air Pumps, General Service Pumps, Forced Lubrication Pumps, Oil Fuel Pressure Pumps, Cargo and Oil Transfer Pumps; Reflux Gas Oil and Gasoline Pumps, Line and Tankage Pumps, Hot Charge Pumps, Acid and other special duty Pumps for Refineries and Cracking Plants, etc.

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THE amazing wear-resisting properties of bearings lined with genuine 'Flower Brand' MAGNOLIA ANTI-FRICTION METAL are due to our unique process of graphiting during manufacture. Over a period of fifty years our original metal has been proved best for 90% of all lined bearings. See the 'Flower Brand' on every ingot. Imitations, often called 'Magnolia,' fail completely to reproduce its low coefficient of friction.

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First of the PEDIGREE BEARING METALS by

MAGNOLIA

EACH Magnolia product has been developed for a specific need. Every ingot is backed by half a century's research and experience. Though lined bearings operate under the most diverse conditions of load and speed, there is always a bearing metal by Magnolia to give trouble-free service. Other examples are:—

For Diesel and other pounding or hammering loads
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For the highest speed work,
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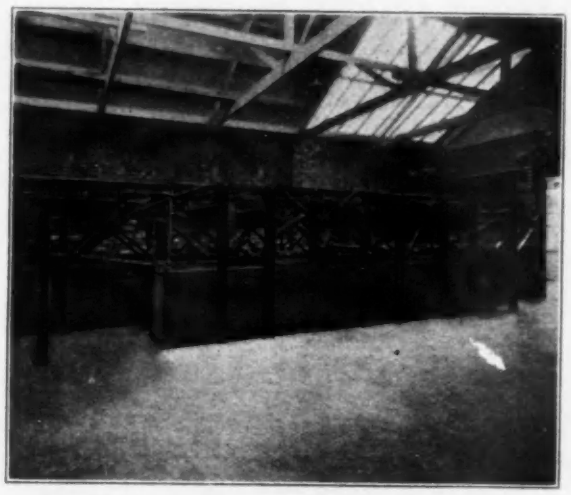
CONVEYORS

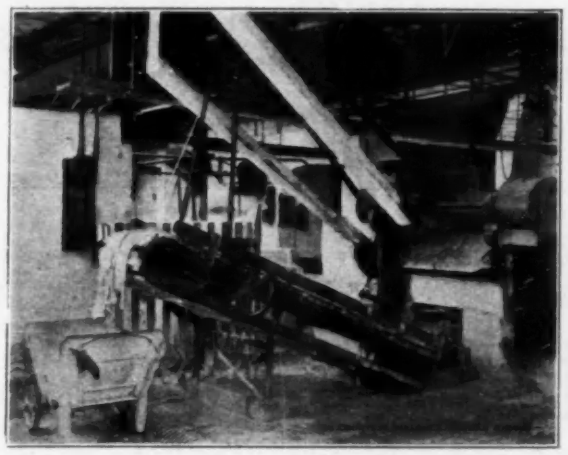
OF ALL TYPES

FOR ALL PURPOSES

A Portable Belt Conveyor for handling sacks, cases, etc.



A Conveyor specially designed by us for carrying castings through the acid, water and soda tanks during the pickling process. Similar types of Conveyors can be used for conveying articles through paint tanks and for similar treatment.



This illustration shows a "B.B." Conveyor in use handling skins in a leather works and is an example of the many ways in which our Conveyors can be employed.

BAGSHAWE

DUNSTABLE. & CO., LTD.

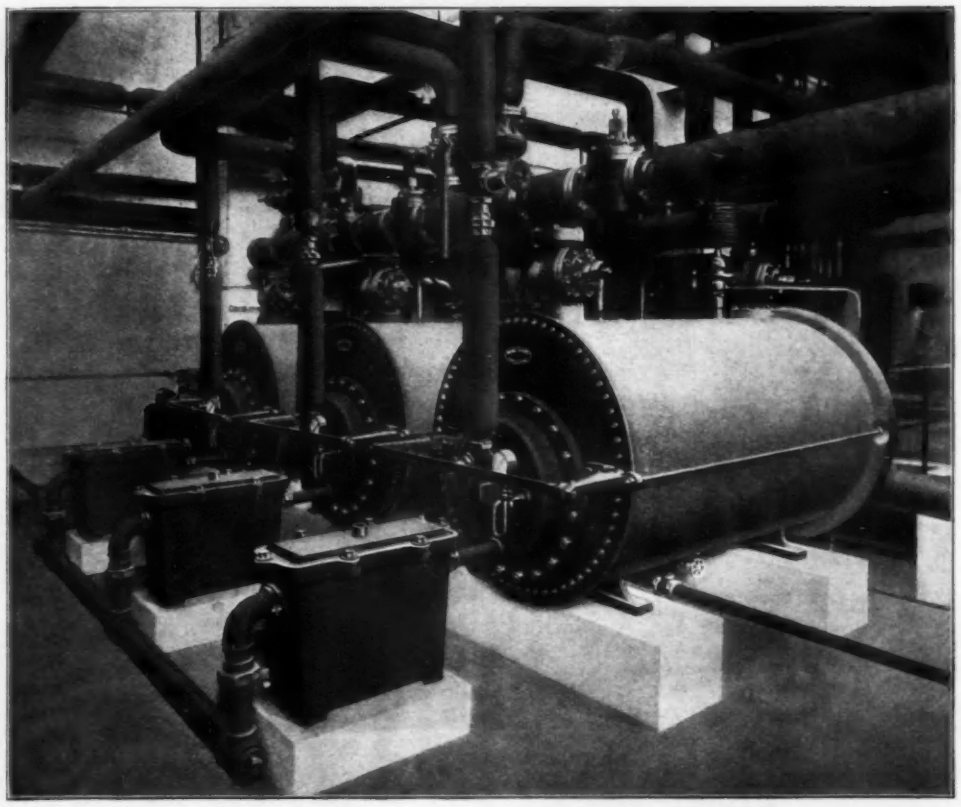
E. 179

ROYLES

CALORIFIERS

ROW'S PATENT

FOR THE **HEATING** AND **HOT WATER SUPPLIES** OF
HOTELS, PUBLIC and INDUSTRIAL BUILDINGS, SHIPS, &c.



Arrangement of **HOT WATER SUPPLY CALORIFIERS** at
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The illustration shows a Battery of Calorifiers, with Mild Steel Casings, complete with Royles Patent Automatic Steam Controls and "Syphonia" Steam Traps, together with the necessary isolating valves and headers, as recently supplied for the above-named hotel. These Calorifiers form a unit of three out of the eight which deal with the entire Heating and Hot Water Services of this latest and most luxurious addition to the famous London Hotels.

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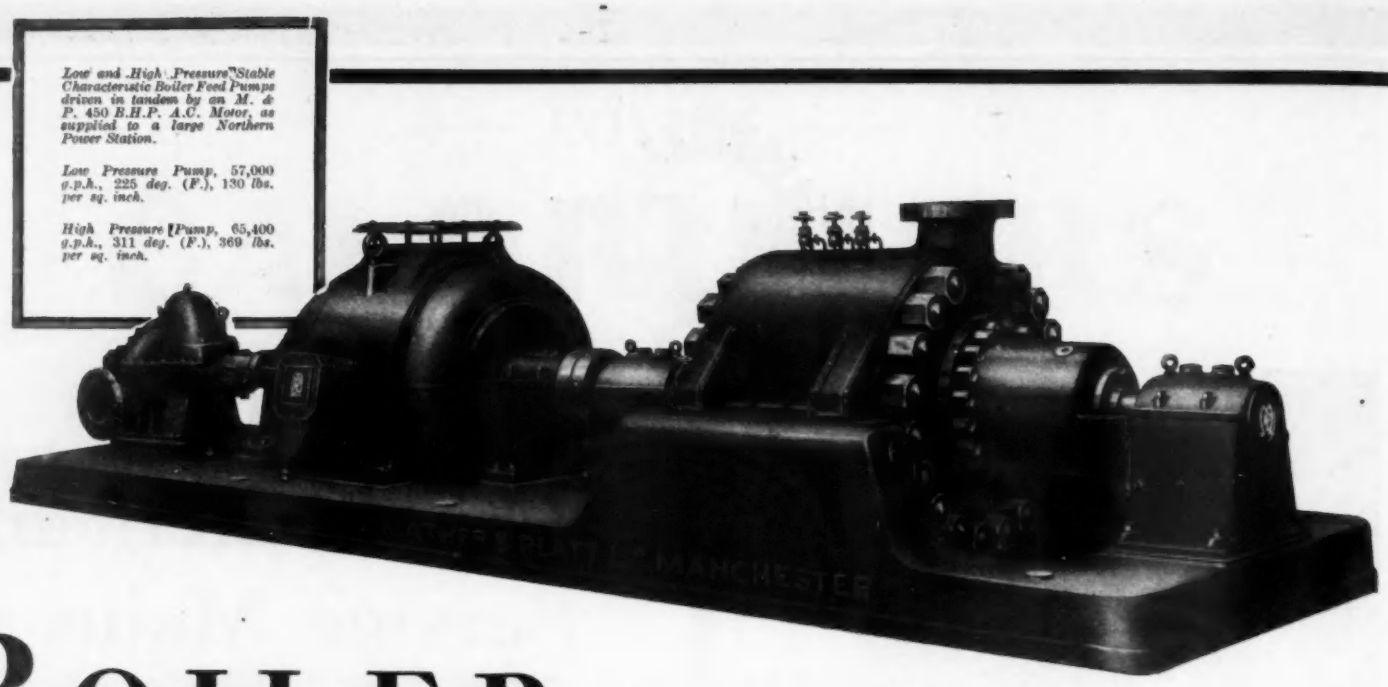

Low and High Pressure Stable Characteristic Boiler Feed Pumps driven in tandem by an M. & P. 450 B.H.P. A.C. Motor, as supplied to a large Northern Power Station.

Low Pressure Pump, 57,000 g.p.h., 225 deg. (F.), 130 lbs. per sq. inch.

High Pressure Pump, 65,400 g.p.h., 311 deg. (F.), 369 lbs. per sq. inch.

BOILER FEED PUMPS

The Centrifugal Pump has now been universally adopted for boiler feeding, and with the increasing pressures and temperatures demanded by modern Power Stations, considerable development work has been required in adapting the Multi-stage Pump to this service.

As we were the original manufacturers of this type of pump in 1876, and have initiated all the improvements in design since that date, we are in a unique position for dealing with this important problem.

We guarantee that our Patent Stable Characteristic Pumps will run in parallel without surge and resultant water hammer in the feed line, and this problem is fully dealt with in our brochure reference P.440a.

We have manufactured, and have in successful operation, feed pumps dealing with :—

Pressures up to 1,250 lbs. per sq. inch.

Temperatures up to 560° F.

Quantities up to 75,000 gallons per hour.

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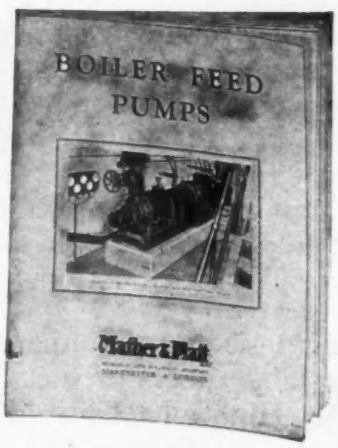

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PARK WORKS - MANCHESTER.

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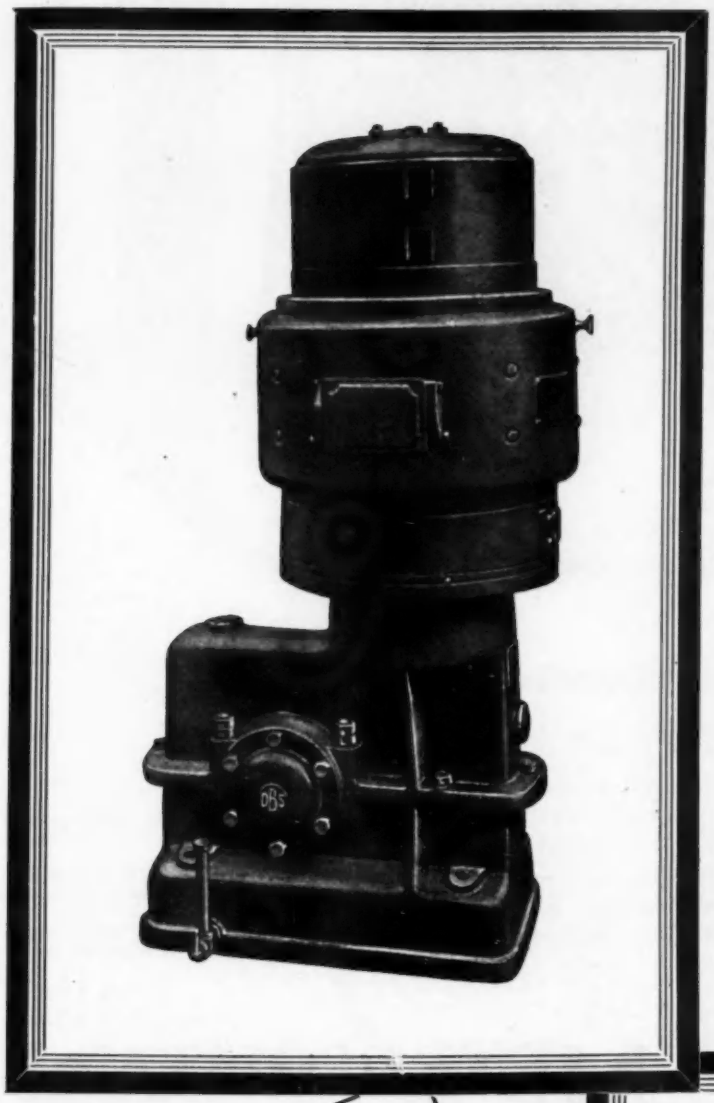
Cut Plant Costs with "David Brown" Geared Motor Units!



In planning new drives, "David Brown" Geared Motor Units offer definite savings. With the robustness and reliability due to simplicity of design, they combine high efficiency, saving power; ease of installation, saving erection costs; and small dimensions, saving valuable space.

The "DBS" patent worm gear embodied in these units is the most efficient worm drive yet evolved, and gives quiet, vibrationless running at all speeds. The large gear ratios which can be obtained in a single stage of reduction enable small, high-speed motors to be used at lower cost than is possible with ordinary drives.

"DBS" Geared Motor Units are easy to instal because there is no need to line up gear and motor on site—no baseplate to spring out of line—no large foundation to provide. Troubles due to bearings overloaded by mal-alignment between motor and gear cannot occur.

"DBS" Geared Motor Units can be arranged neatly out of the way, leaving the maximum room for productive plant. There are no visible moving parts beyond the coupling to cause dust, noise or danger, and they require no attention beyond lubrication every few months.

To obtain these advantages combined with the security of refined design, controlled material, and supreme workmanship, specify "David Brown."

Spur, spiral, bevel, worm, single and double helical gears of all sizes.

Worm reducing gears, upright, inverted and vertical types.

Worm gear units, horizontal and vertical types.

Single and double reducing helical gear units.

Change speed gear boxes of all types.

Bevel increasing and reducing gears.

Turbine gears.

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"STANDARD"
Cast Iron
HAMMERED
PISTON RINGS

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Specify
Them
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N-sure
Dependability
Accuracy
Rapid
Delivery.

Our Piston Rings represent the STANDARD by which other Rings are judged. They are a product of specialisation and experience in PISTON RING Manufacture extending over 30 years.

They will
GIVE YOU THE RESULTS YOU WANT!

All sizes from 1½" to 72" diameter.

THE STANDARD PISTON RING & ENGG. CO., LTD.,
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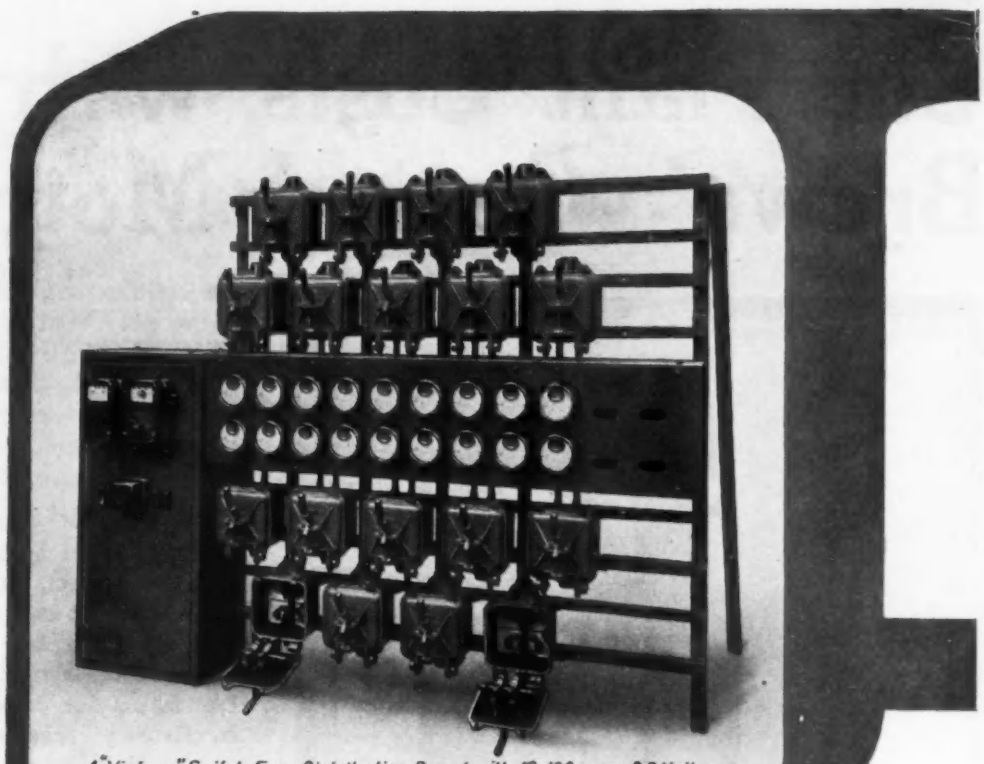
SHEFFIELD.

Telephone: No. 2140. Telegrams: Ossap, Sheffield.



A "Vickers" Switch Fuse Distribution Board with 18-100 amps D.P. Units & an Ammeter for each Circuit. For use on a 3 Phase - 4 Wire System & space for 4 additional circuits. Summation Metering Cubicle on left.

THE LABOURER'S SWITCH.

Skill is simply not required to deal with the robust "Vickers" Switch-Fuse. The "break" and "make" cannot help but be quick, it is ironclad and dampproof, and the case cannot be opened for fuse renewal, or for anything else, unless the switch is "off." And more, the "Vickers" Switch-Fuse is remarkably LOW IN COST.

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STEAM HAMMERS
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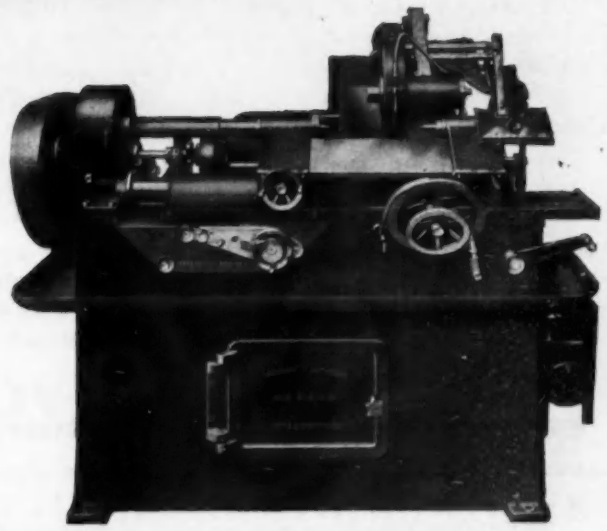
MALLEABLE IRON & STEEL
Including all sizes of Round, Square, and Flat Bars, Rolled Girders from 3in. to 20in. deep; Tees, Angles, &c. &c.
GREAT VARIETY OF HEAVY-SIZED
PLAIN & CHEQUERED PLATES
BOILER & TANK PLATES, &c., in Iron and Siemens Steel.
Quotations and Sections on application. Shipment Orders promptly executed
Correspondence Solicited.

THREAD GRINDING MACHINES

Patent No. 294589 (Others Pending).

FOR TAPS AND GAUGES,

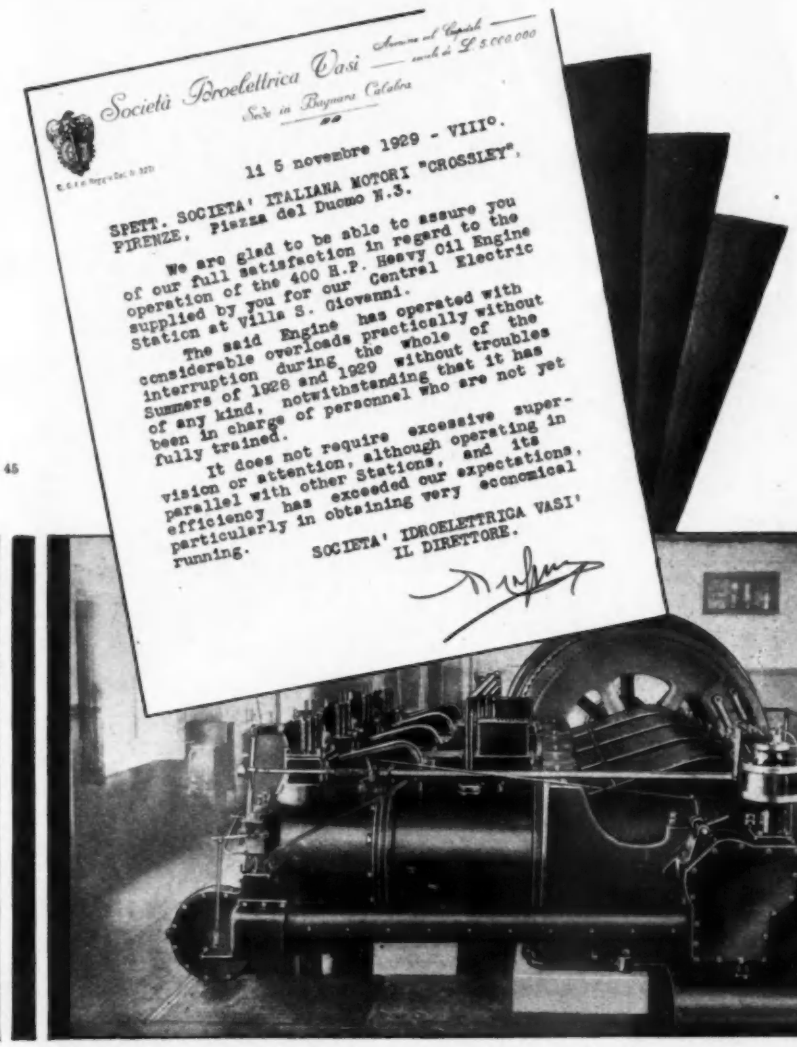


EASY AND ACCURATE WHEEL DRESSING CAN BE IMMEDIATELY EFFECTED, WHATEVER THE SHAPE OR PITCH, WITHOUT REMOVING WORK OR ALTERING SETTING.

THERE ARE MANY OTHER GOOD FEATURES WORTH INVESTIGATION.

Designed and Manufactured by

ATKINS (PETERBOROUGH) LTD., PETERBOROUGH.


Società Idroelettrica Vasi
Sede in Bagnara Calabra
li 5 novembre 1929 - VIIIº.
SPETT. SOCIETA' ITALIANA MOTORI "CROSSLEY",
FIRENZE, Piazza del Duomo N.3.
We are glad to be able to assure you of our full satisfaction in regard to the operation of the 400 H.P. Heavy Oil Engine supplied by you for our Central Electric Station at Villa S. Giovanni.
The said Engine has operated with considerable overloads practically without interruption during the whole of the Summers of 1928 and 1929 without troubles of any kind, notwithstanding that it has been in charge of personnel who are not yet fully trained.
It does not require excessive supervision or attention, although operating in parallel with other Stations, and its efficiency has exceeded our expectations, particularly in obtaining very economical running.
SOCIETA' IDROELETTRICA VASI'
IL DIRETTORE.

P. 45

CROSSLEY-PREMIER

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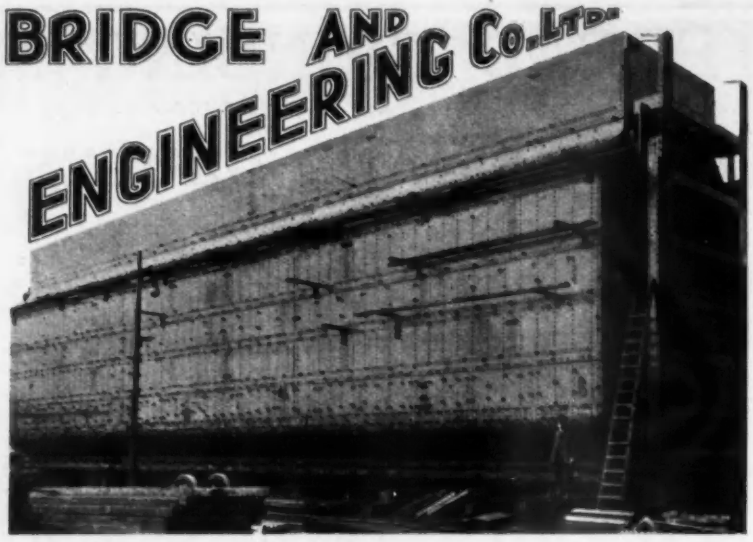

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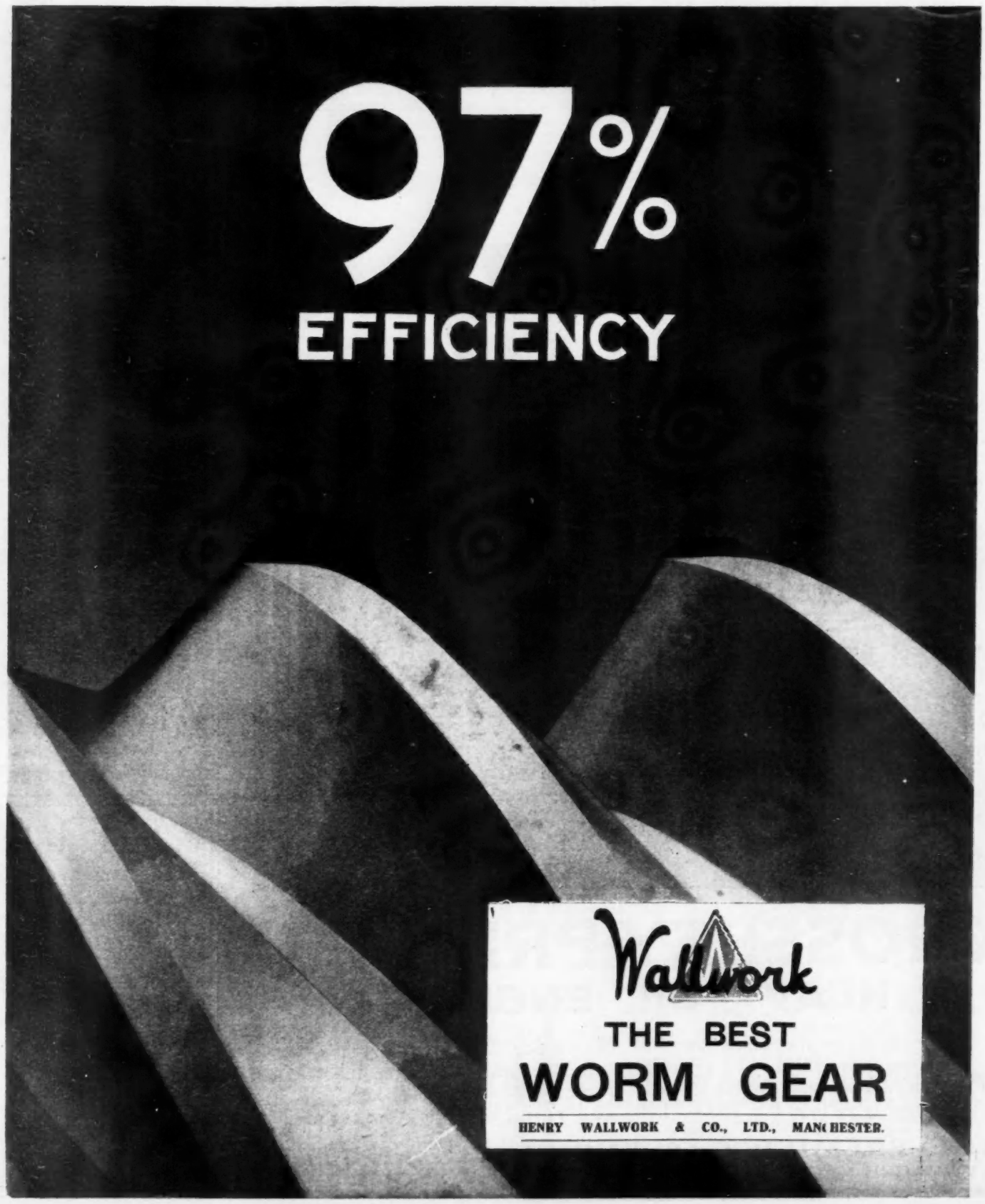

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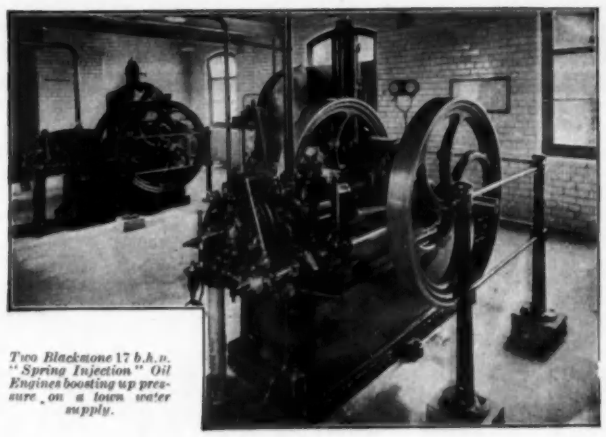

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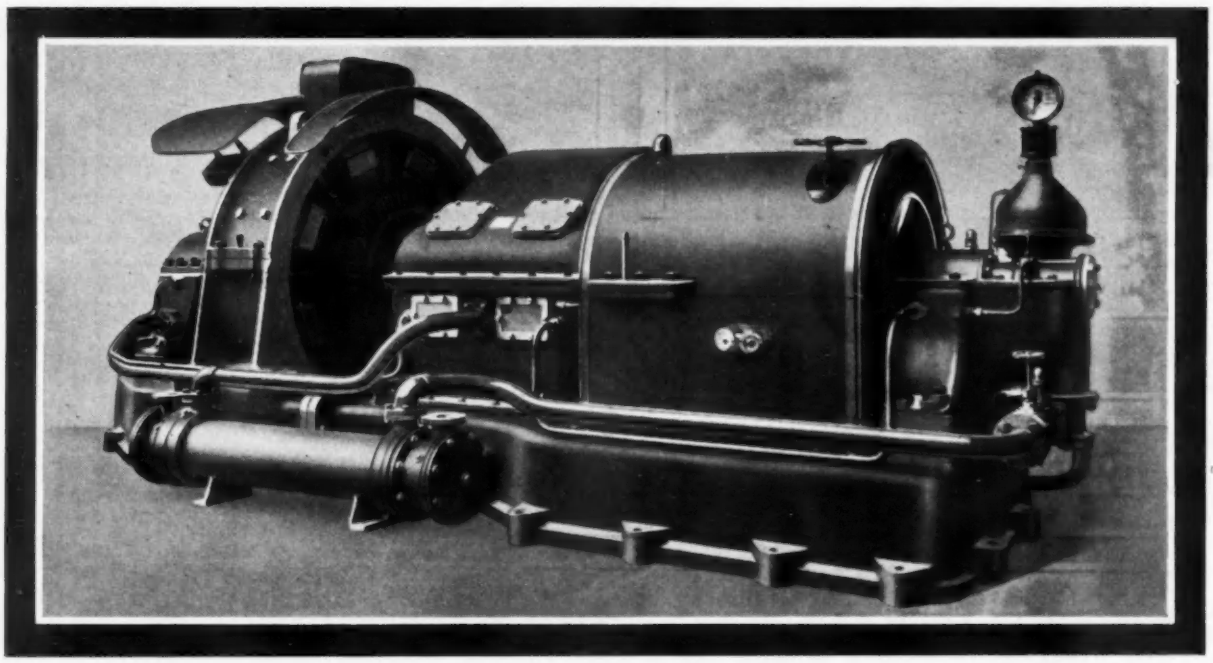

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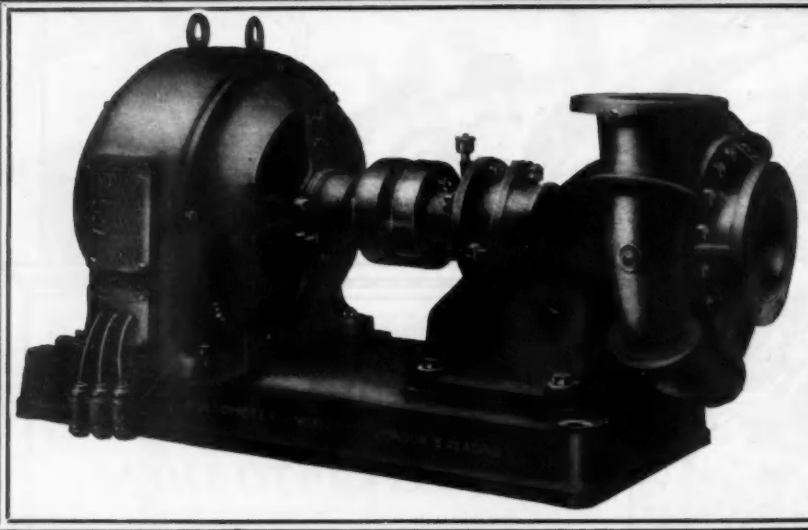

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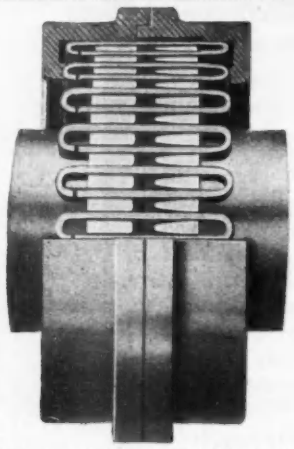

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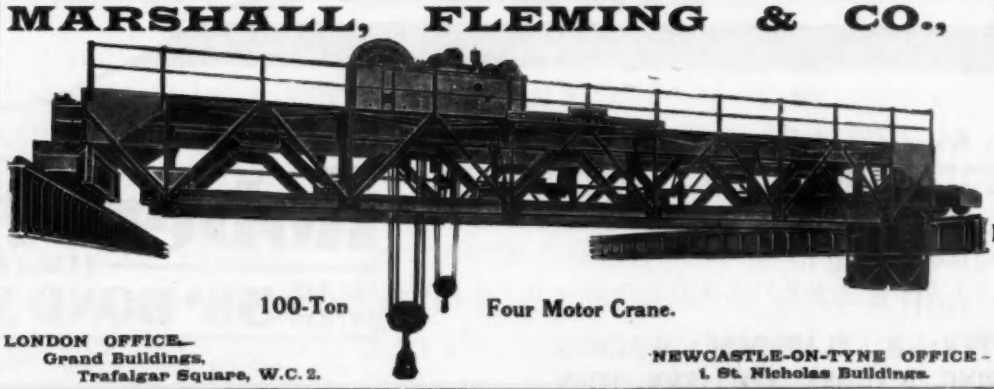

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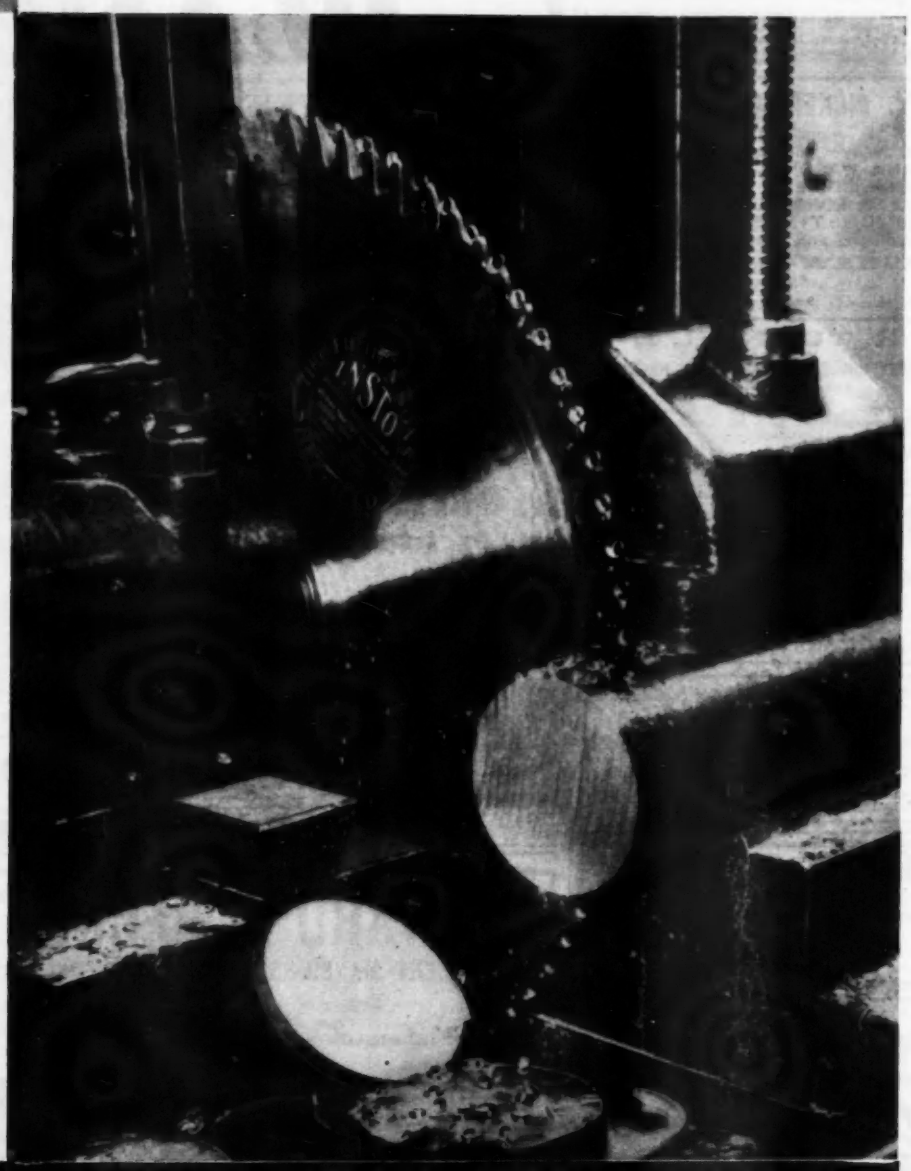

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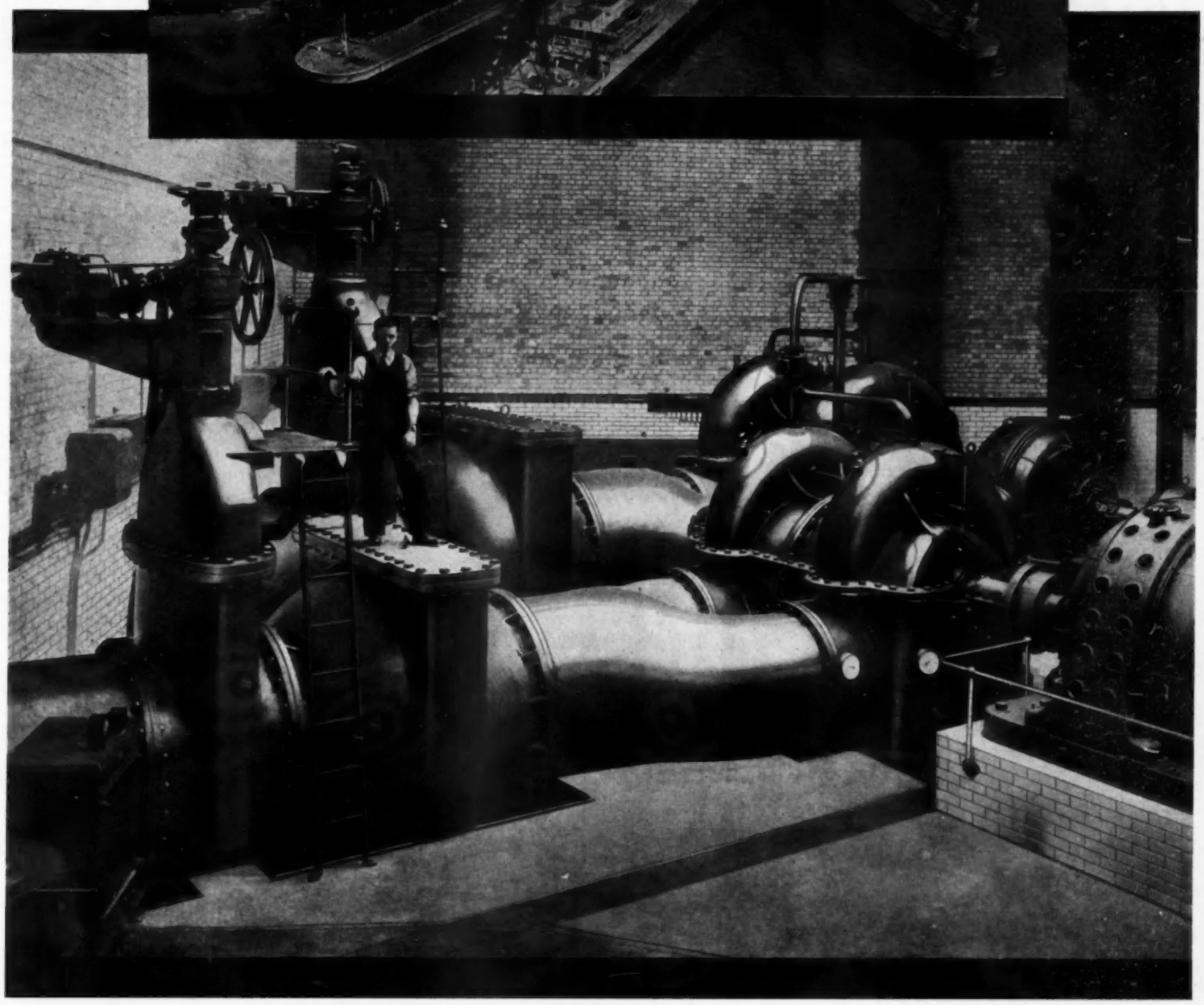

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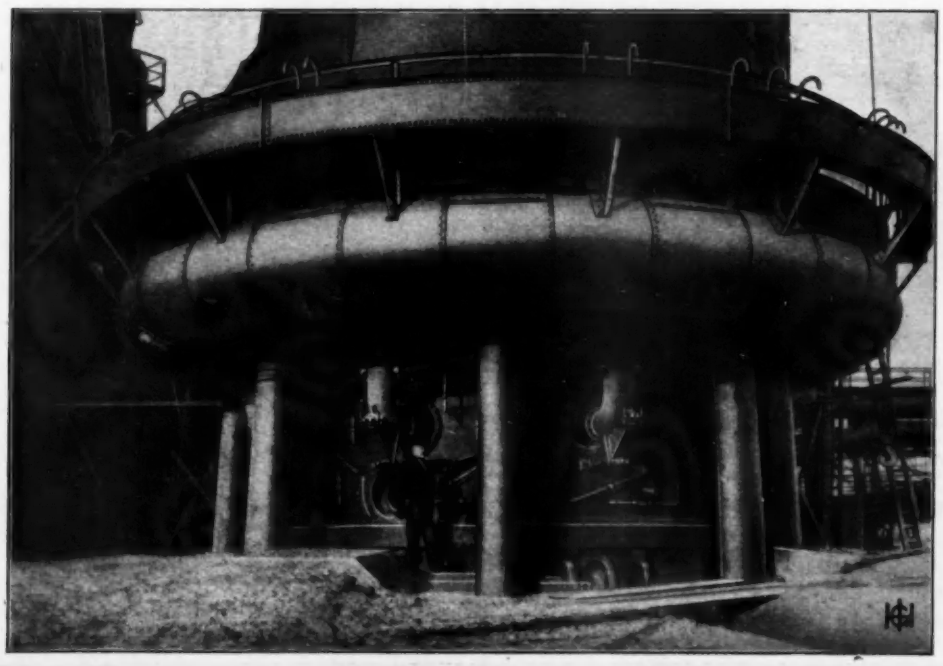

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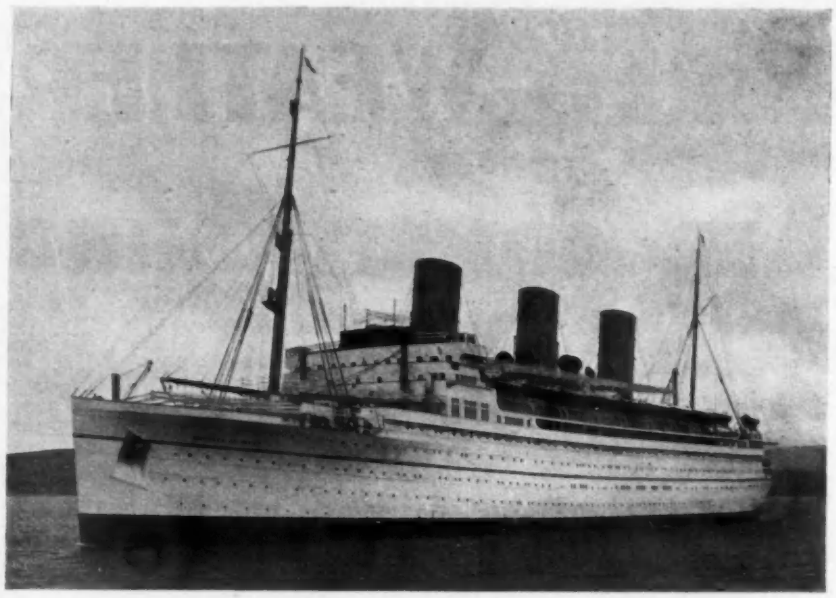

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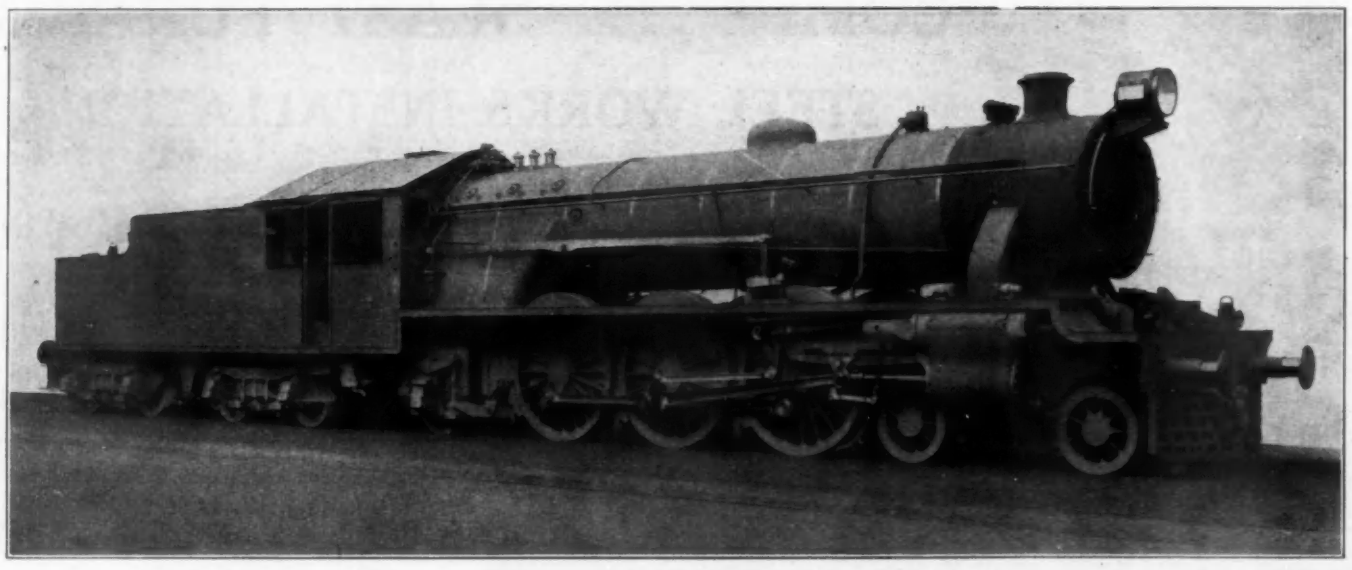

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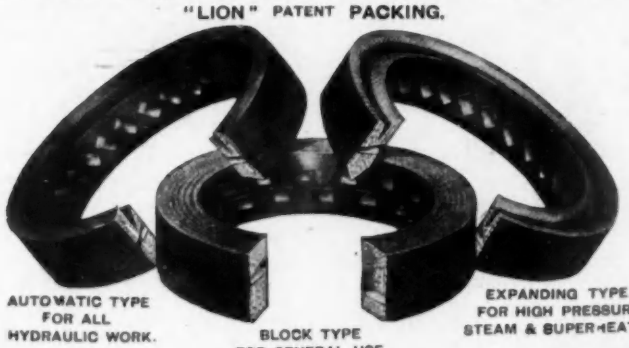

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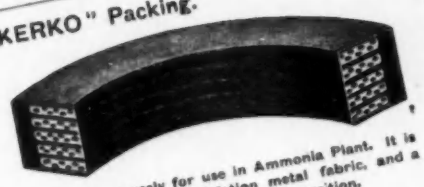

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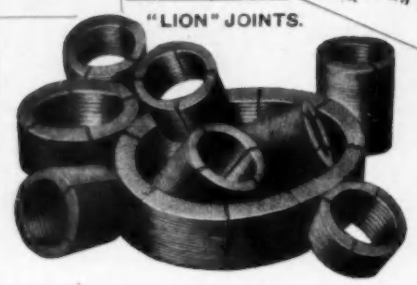

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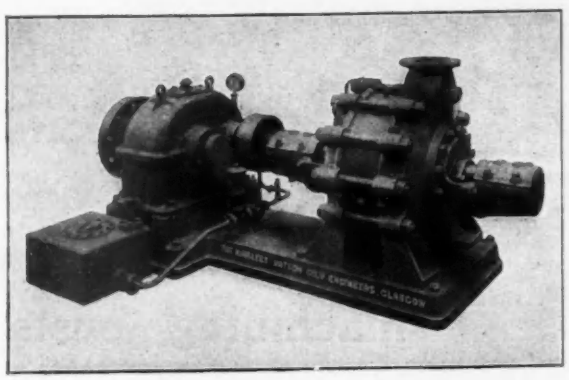

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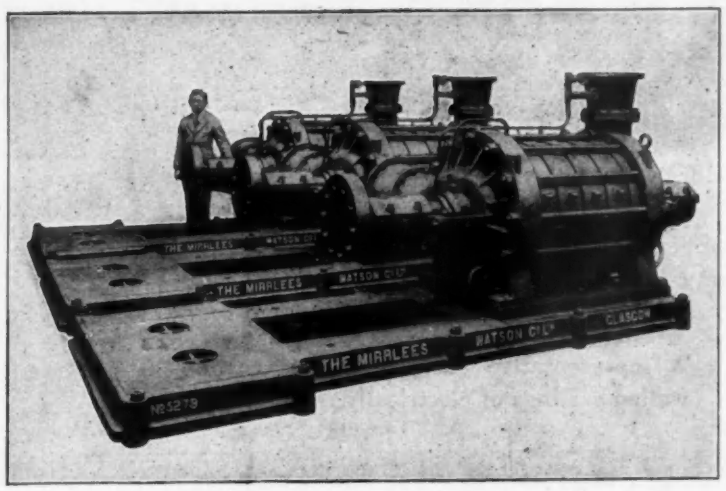

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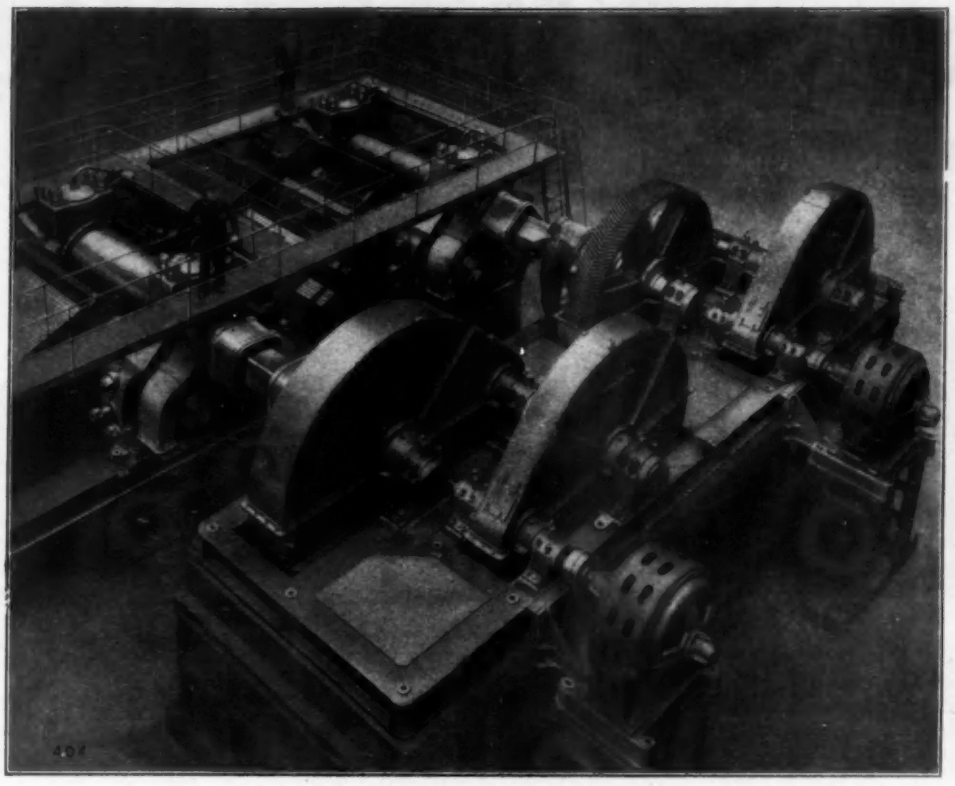

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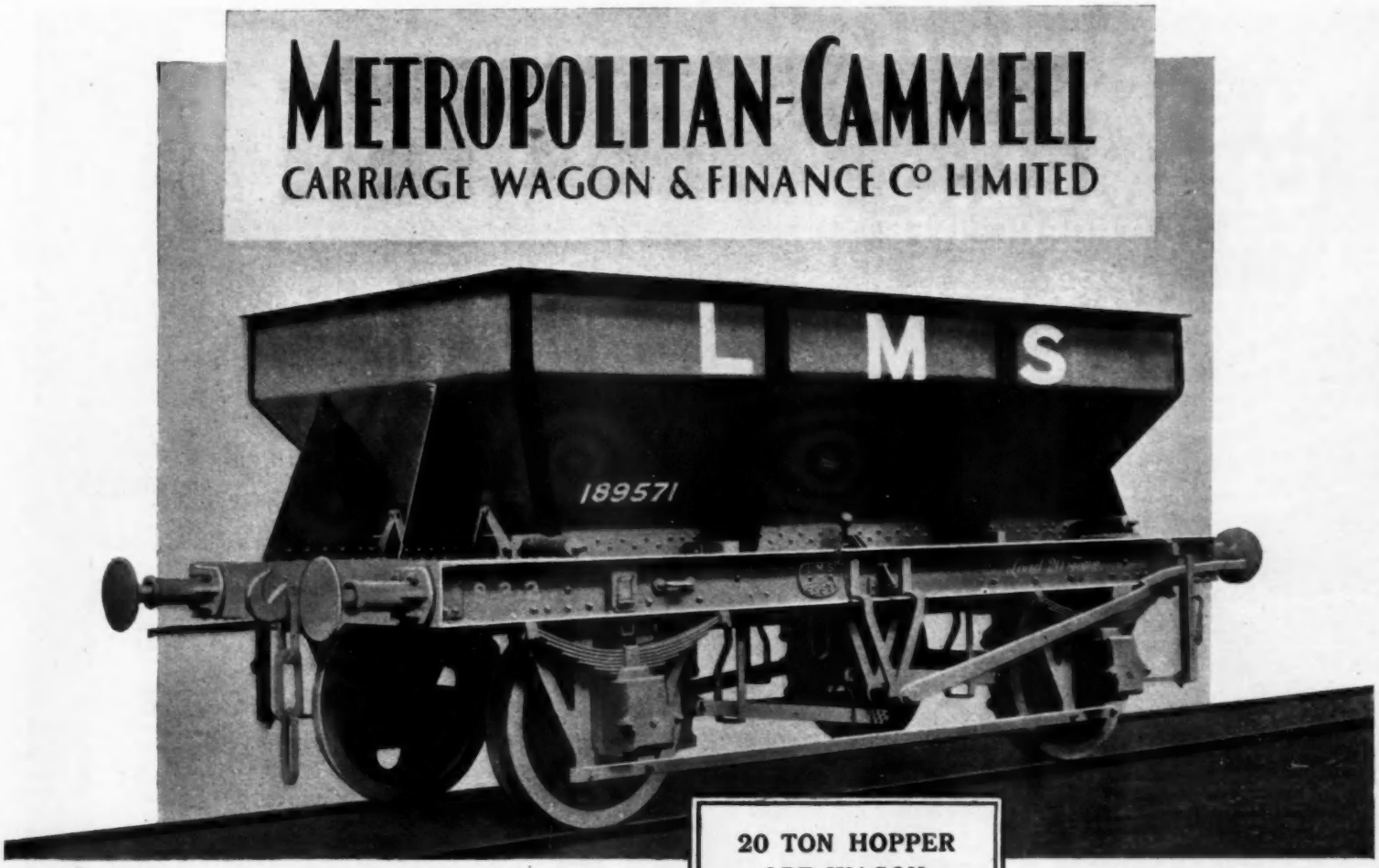

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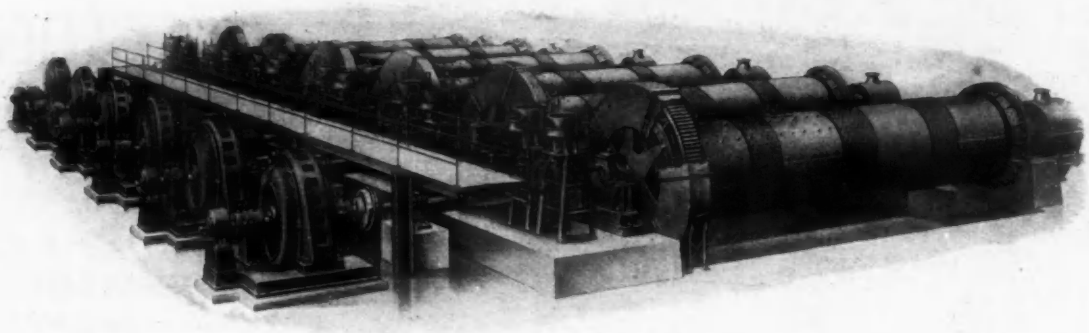

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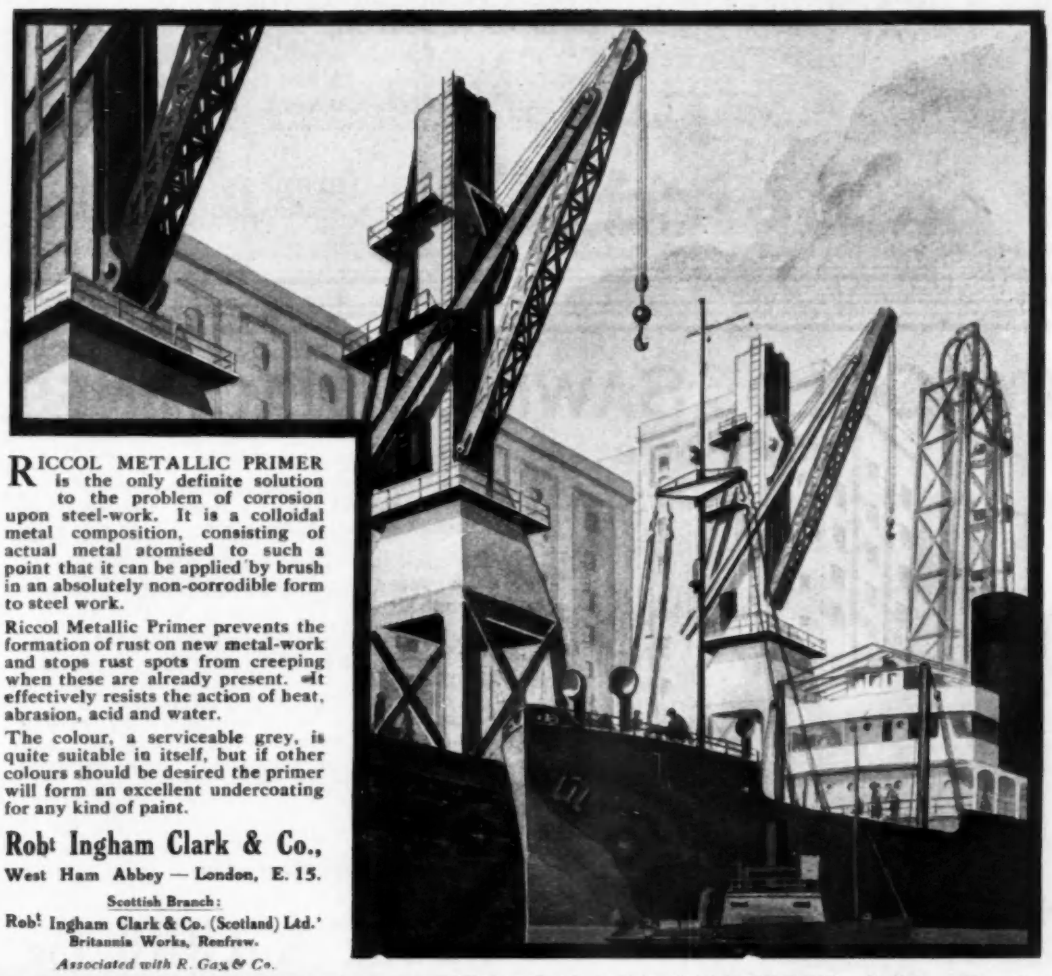

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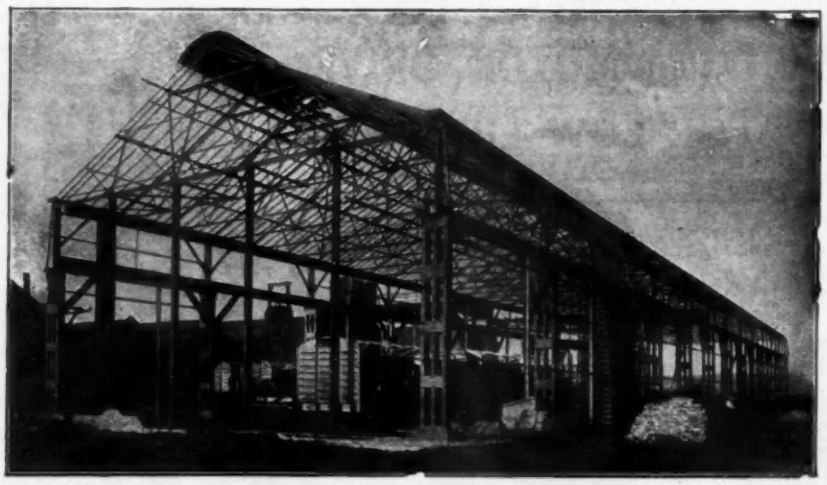

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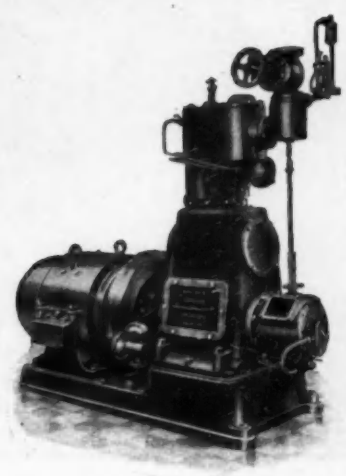

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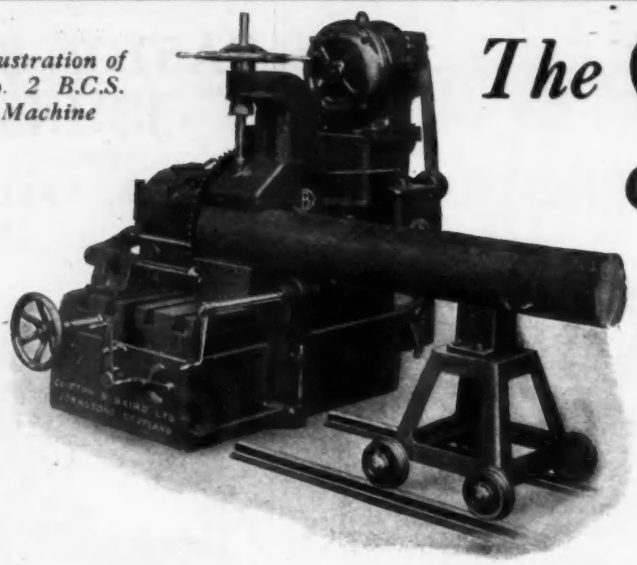

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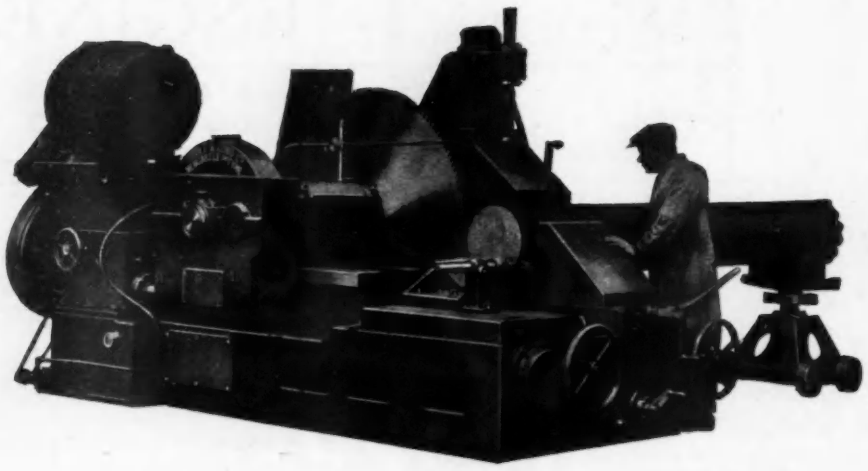

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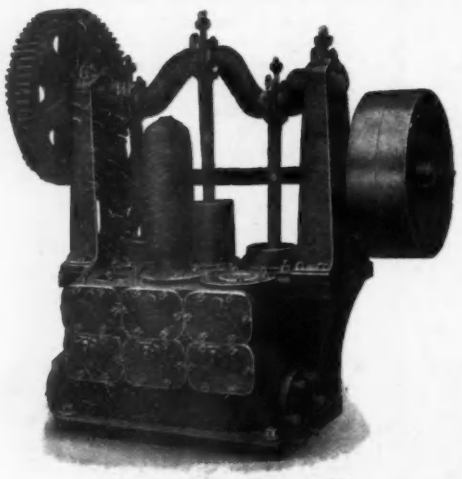

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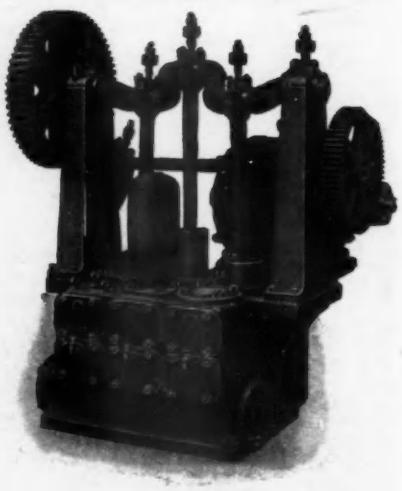

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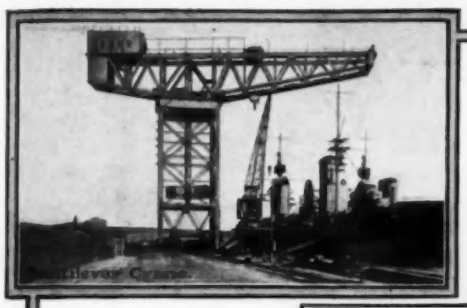

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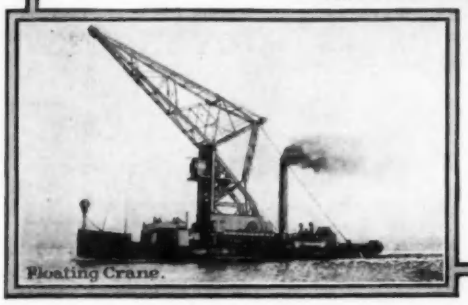
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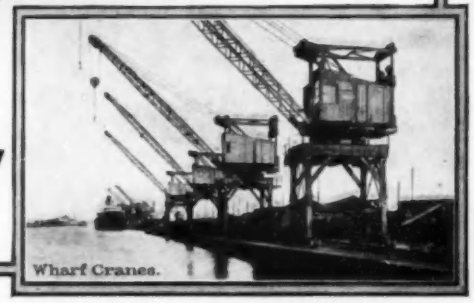
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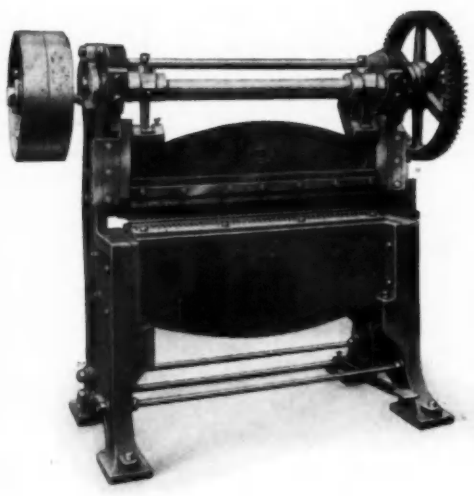
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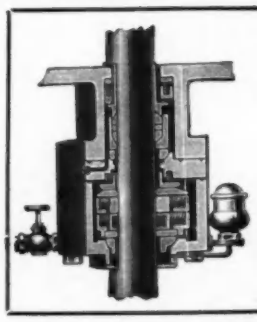

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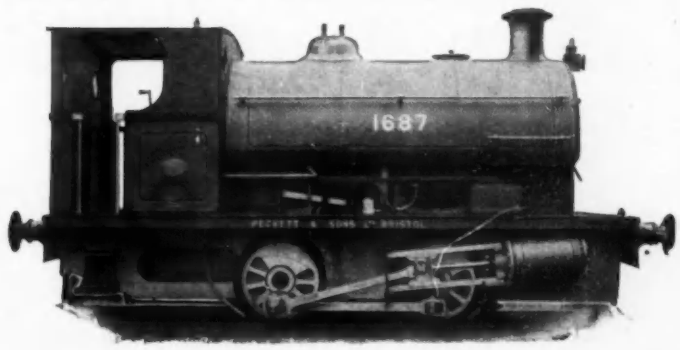

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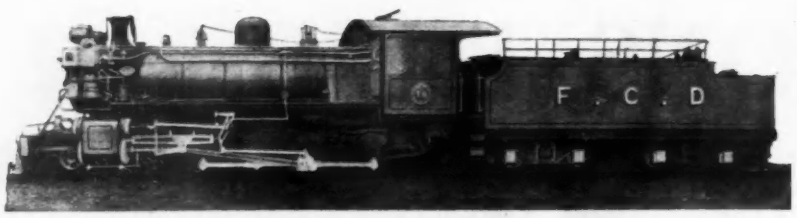

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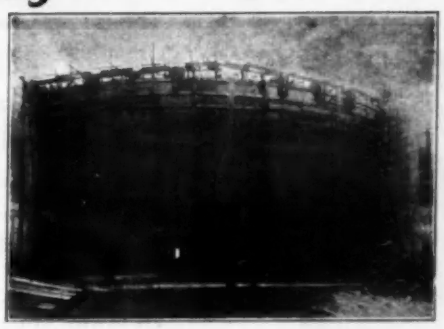

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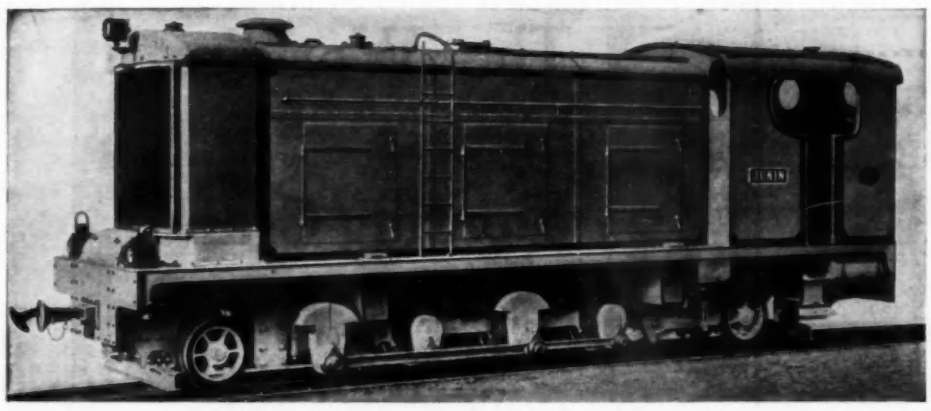

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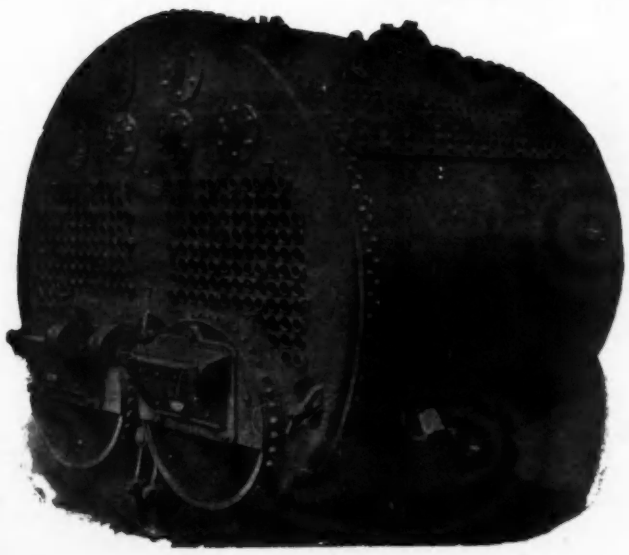

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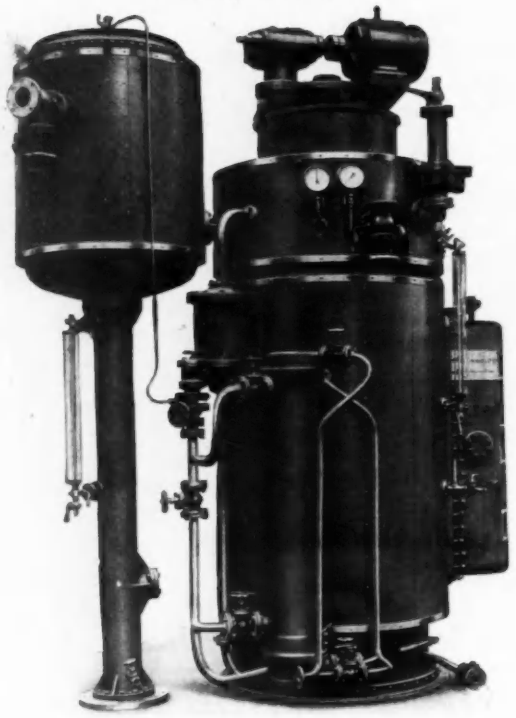

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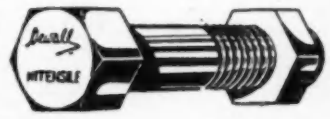

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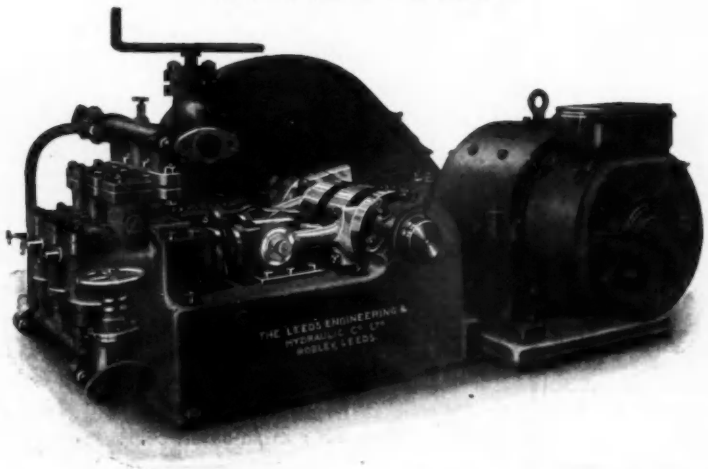

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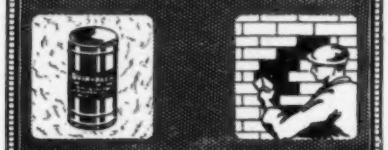
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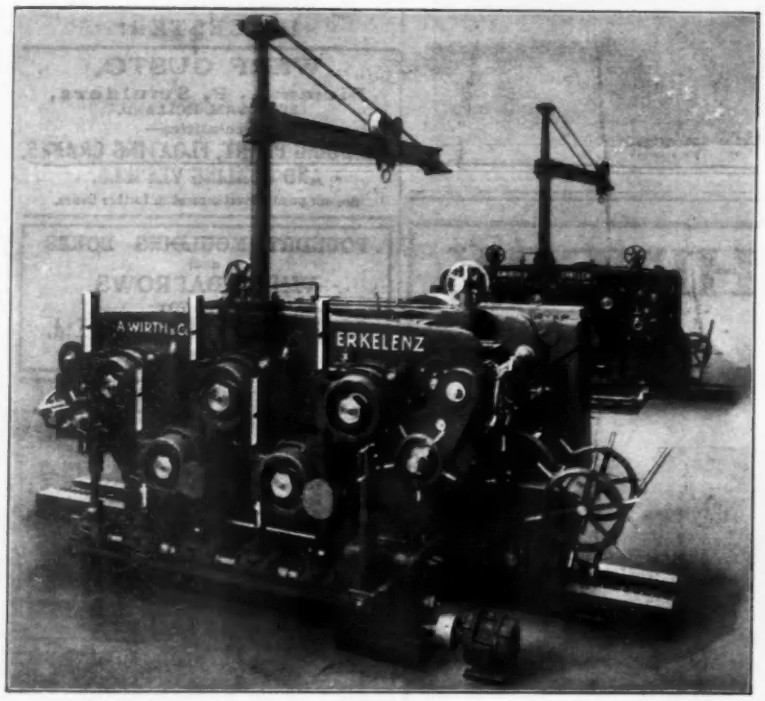

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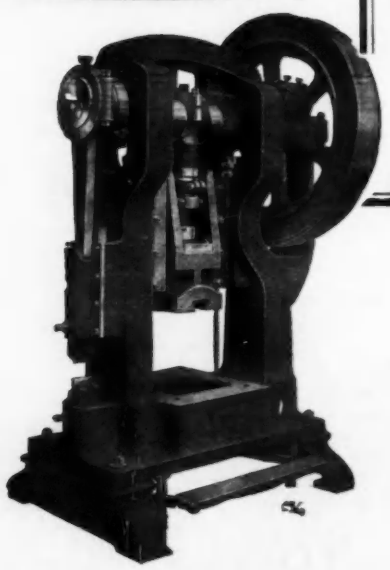

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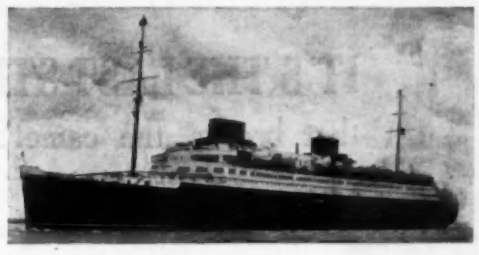
"EUROPA"  "BREMEN"

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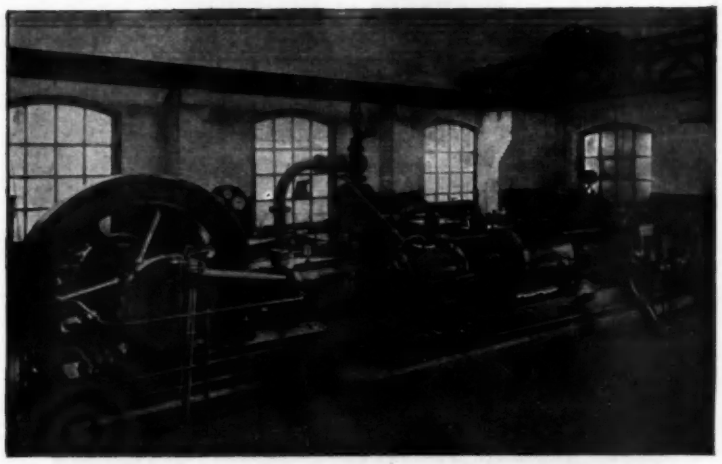

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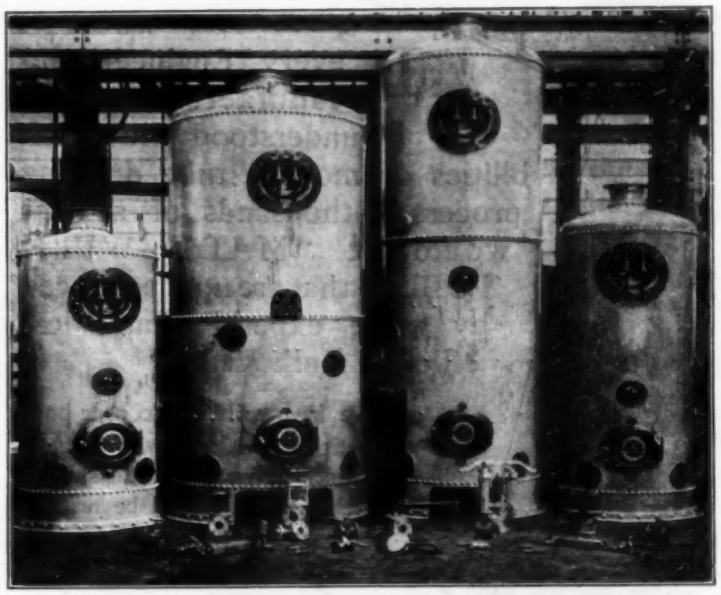

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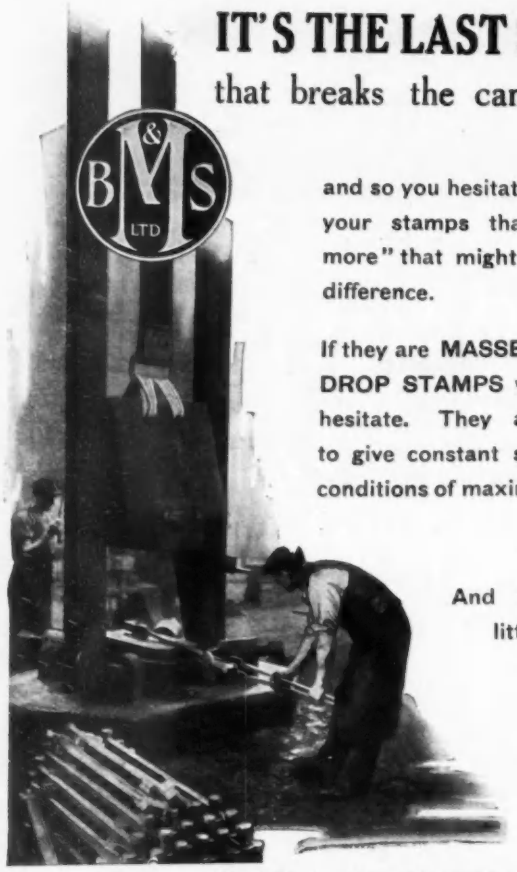

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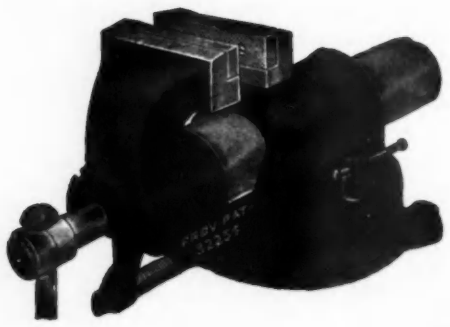

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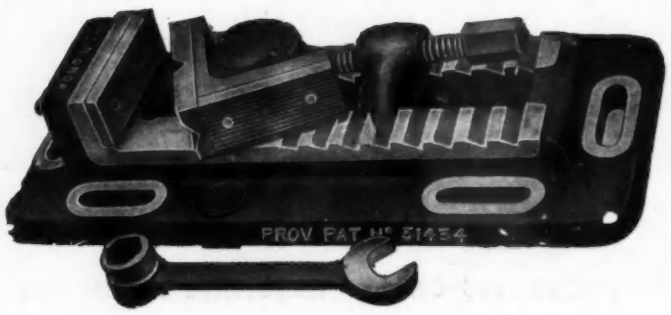

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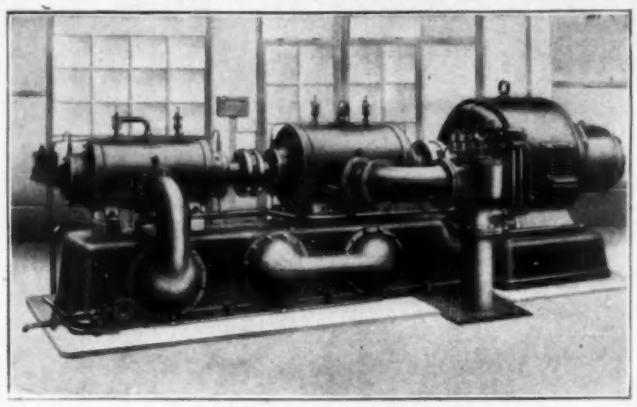

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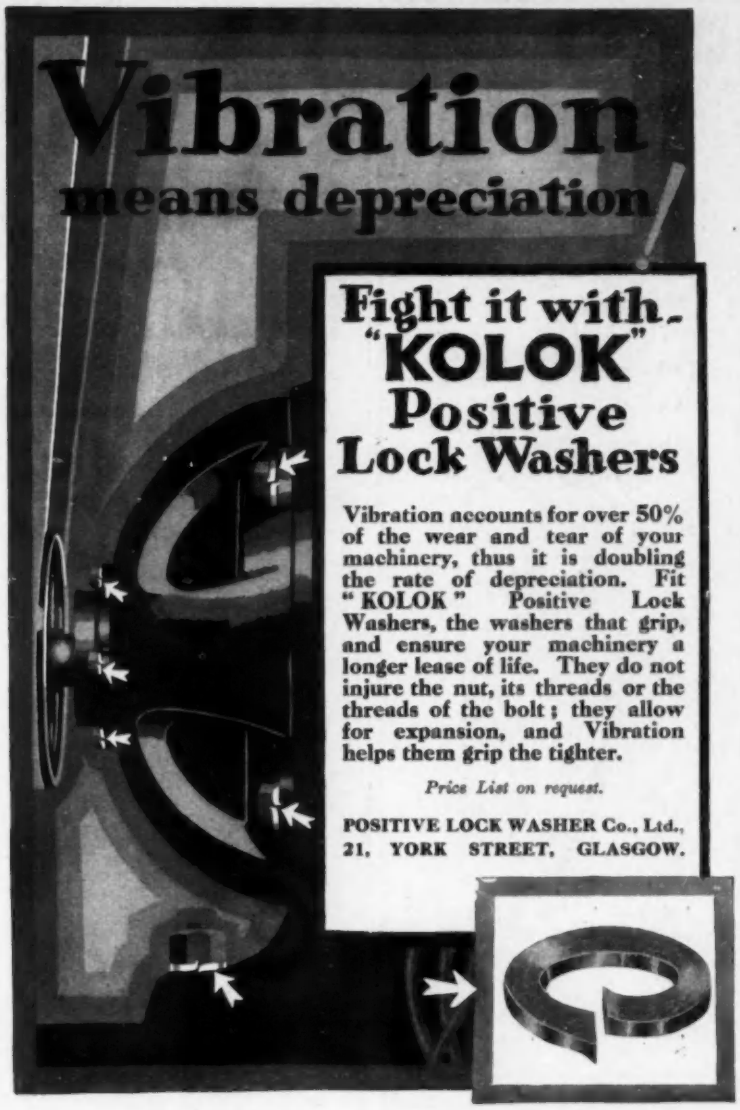
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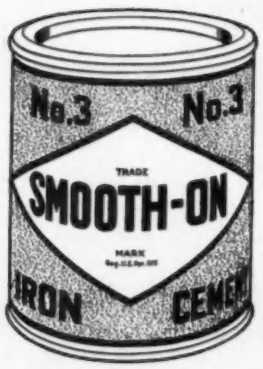

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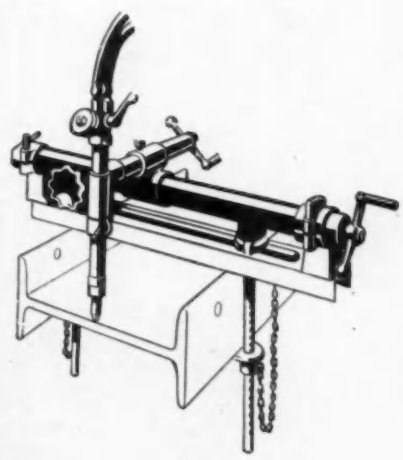

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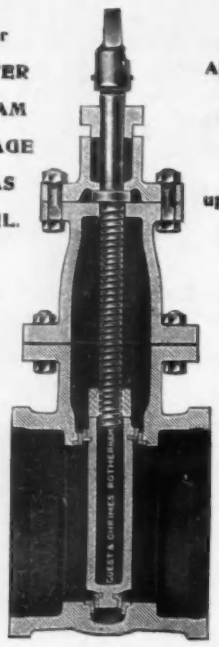

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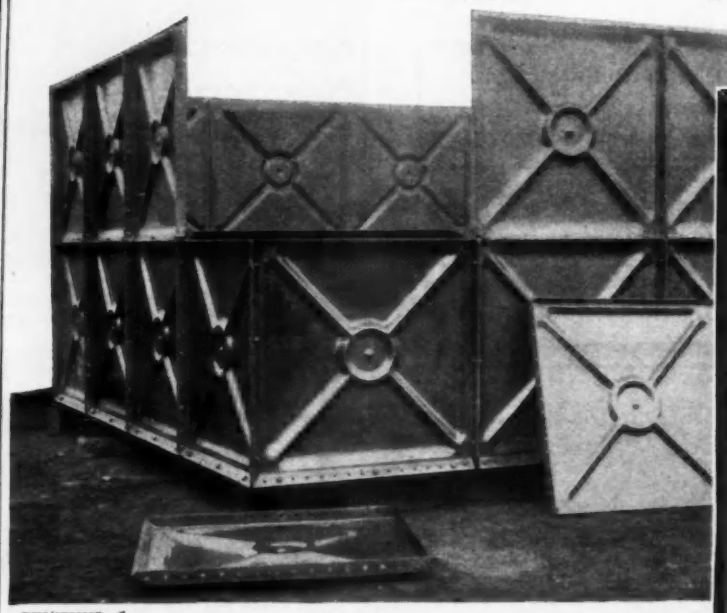

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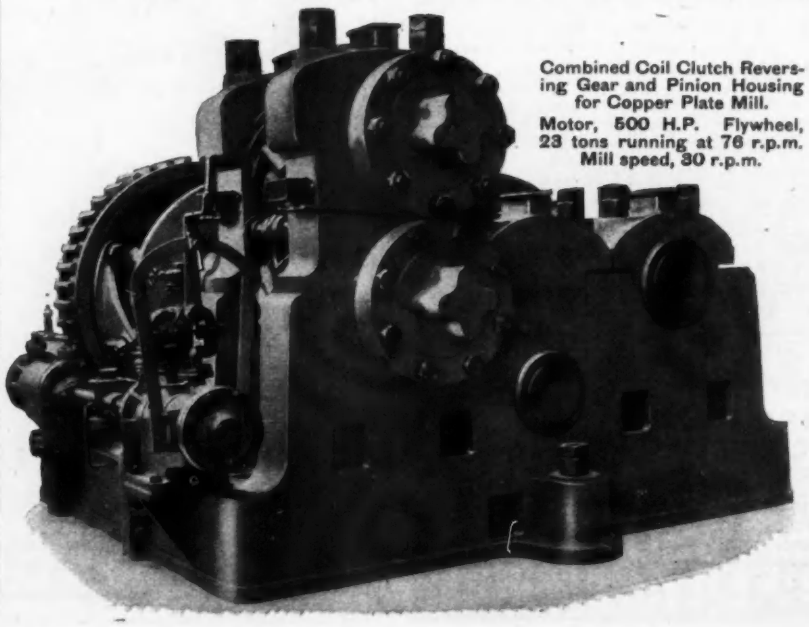

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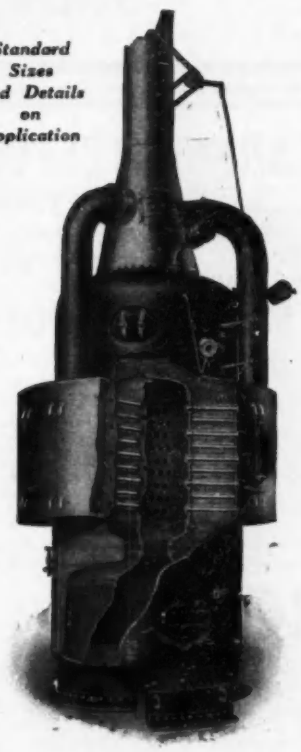

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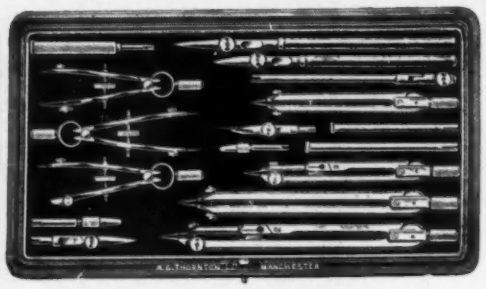

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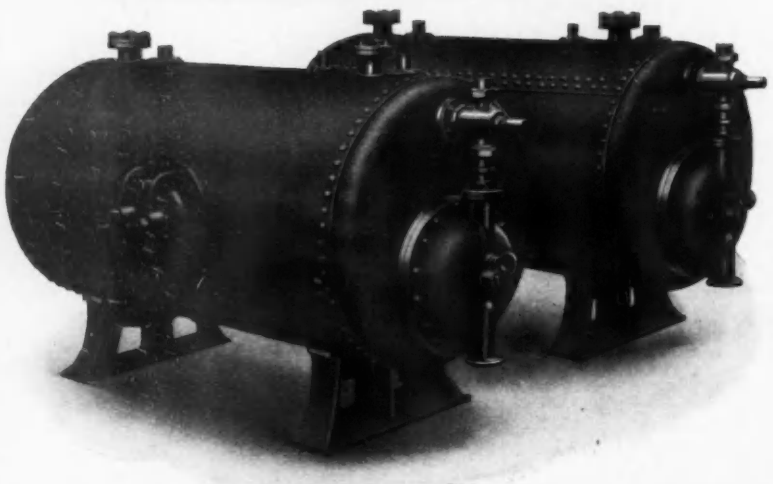

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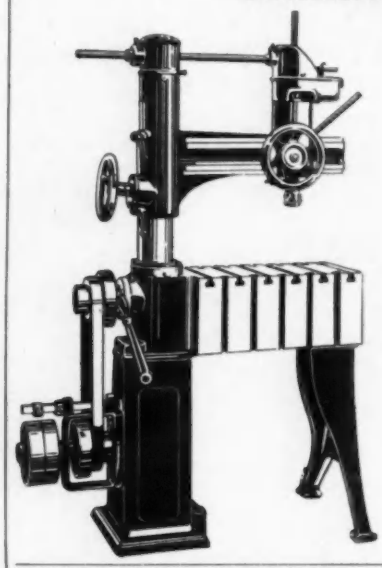

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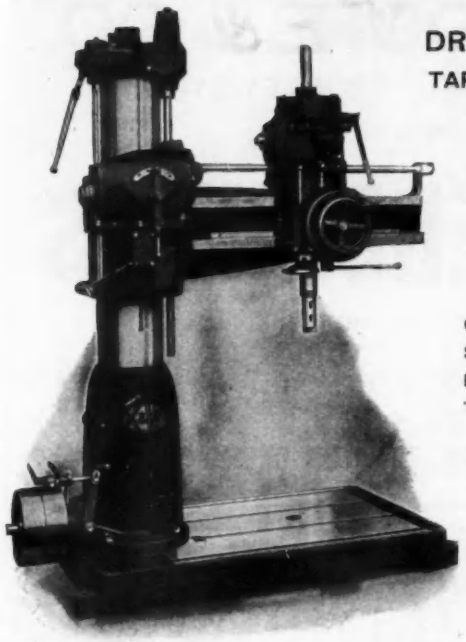

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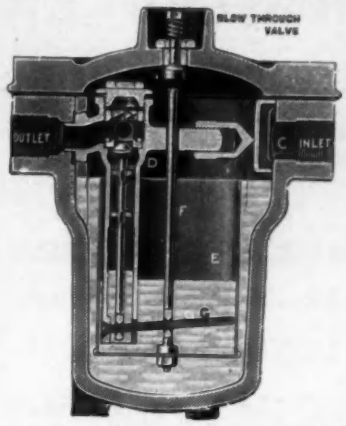

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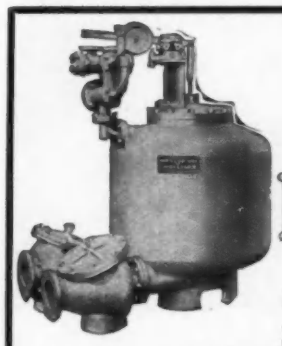

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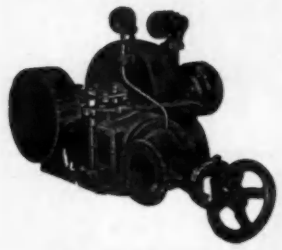

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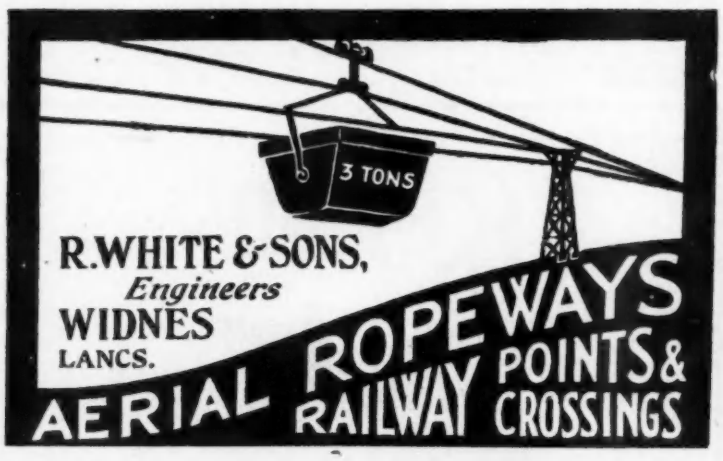

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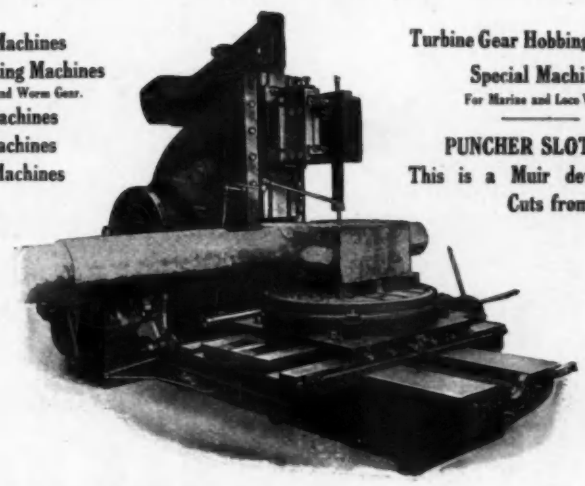

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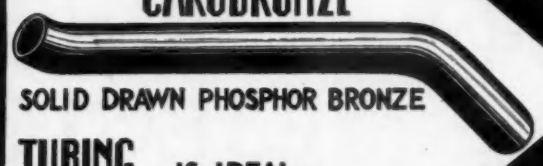

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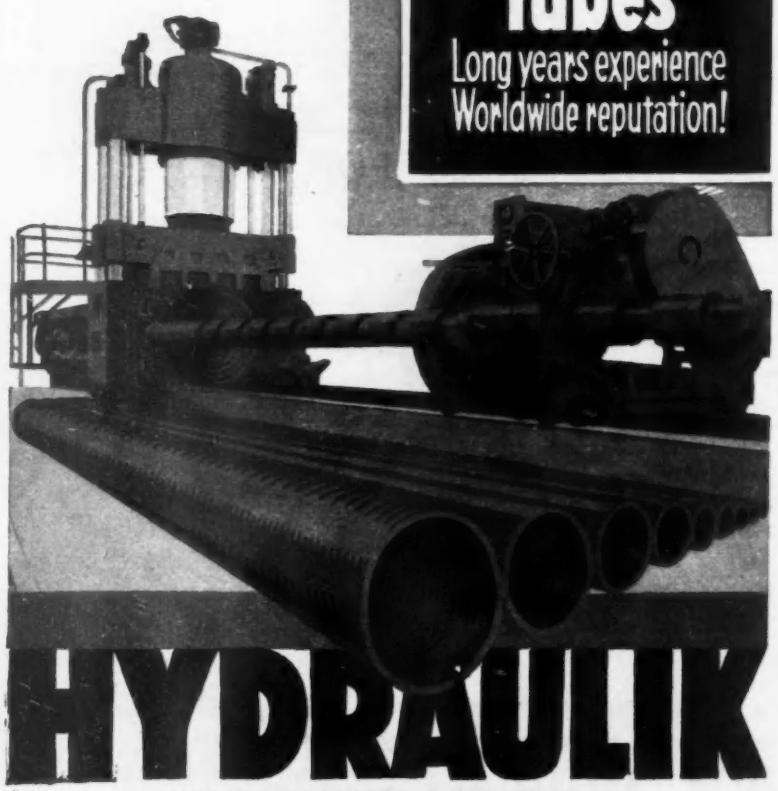

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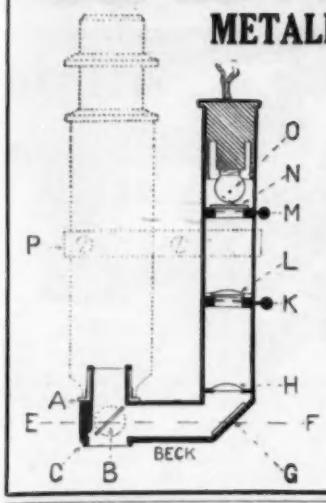

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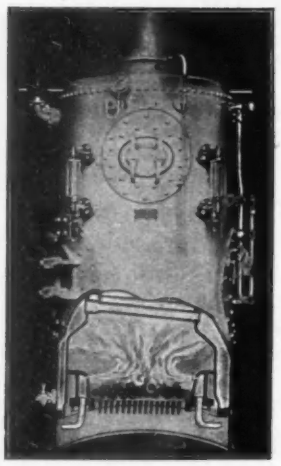

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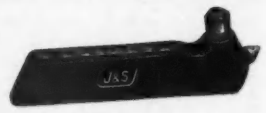

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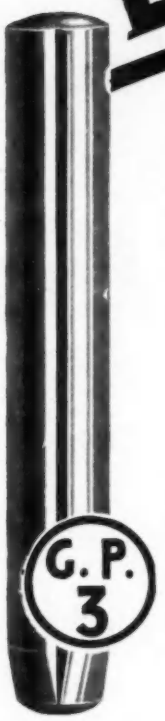

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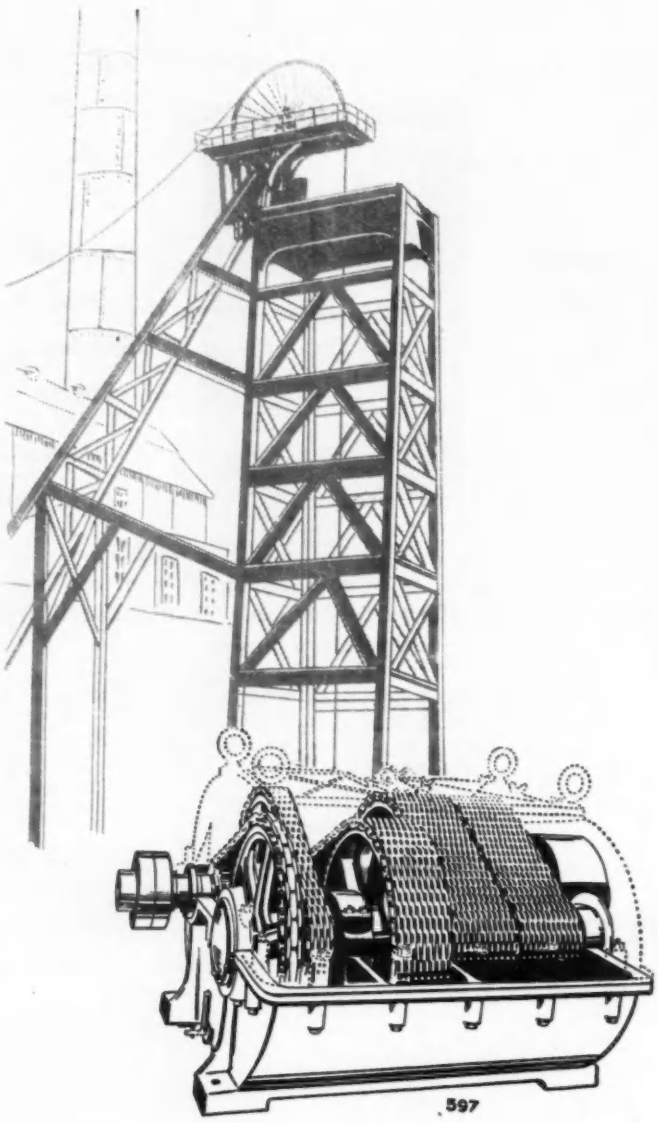

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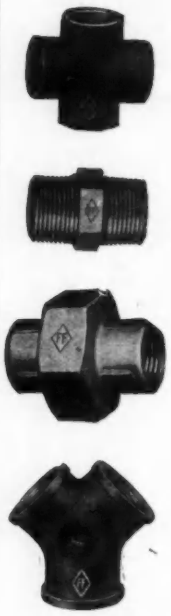

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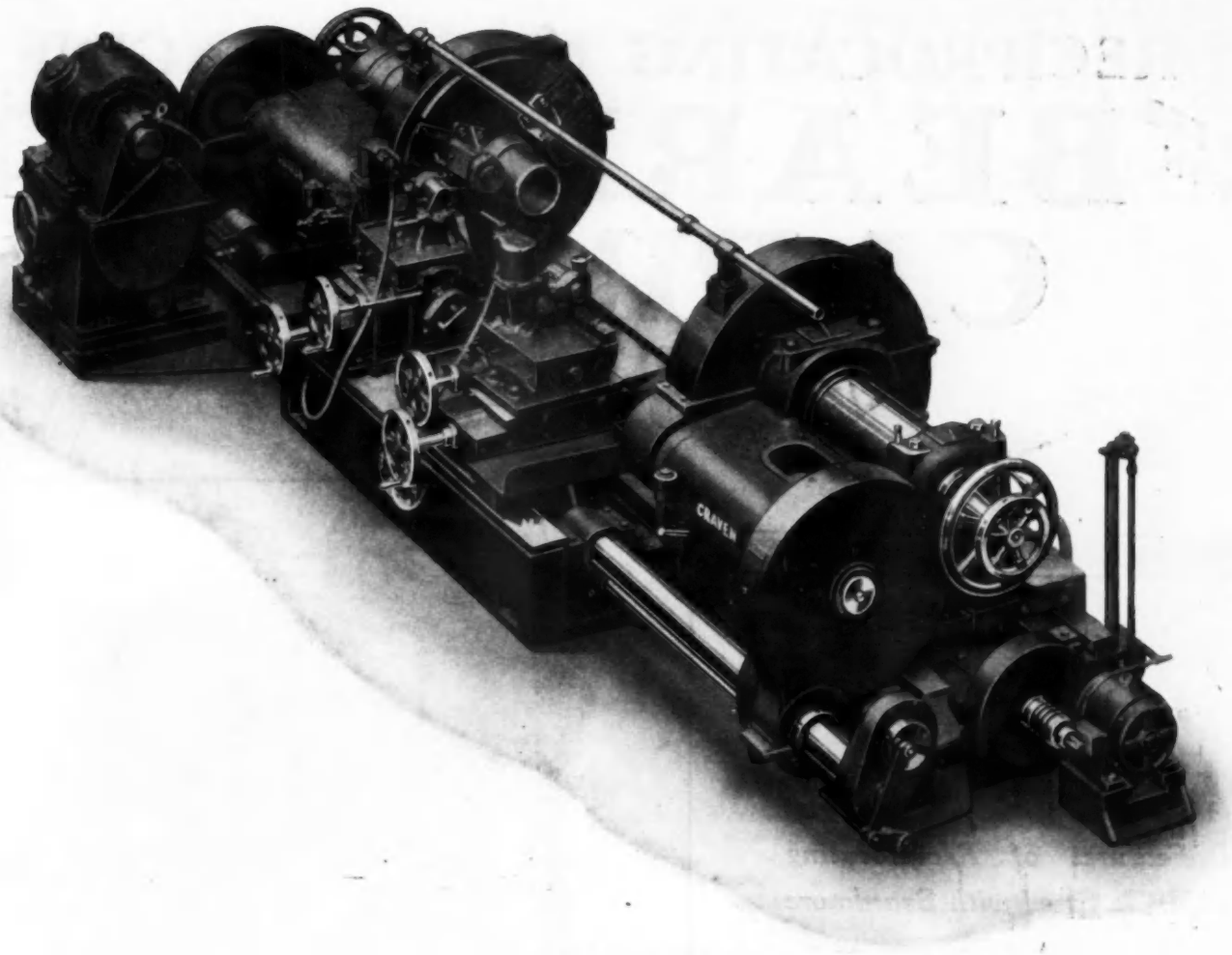

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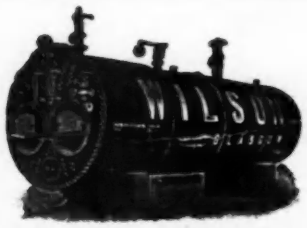

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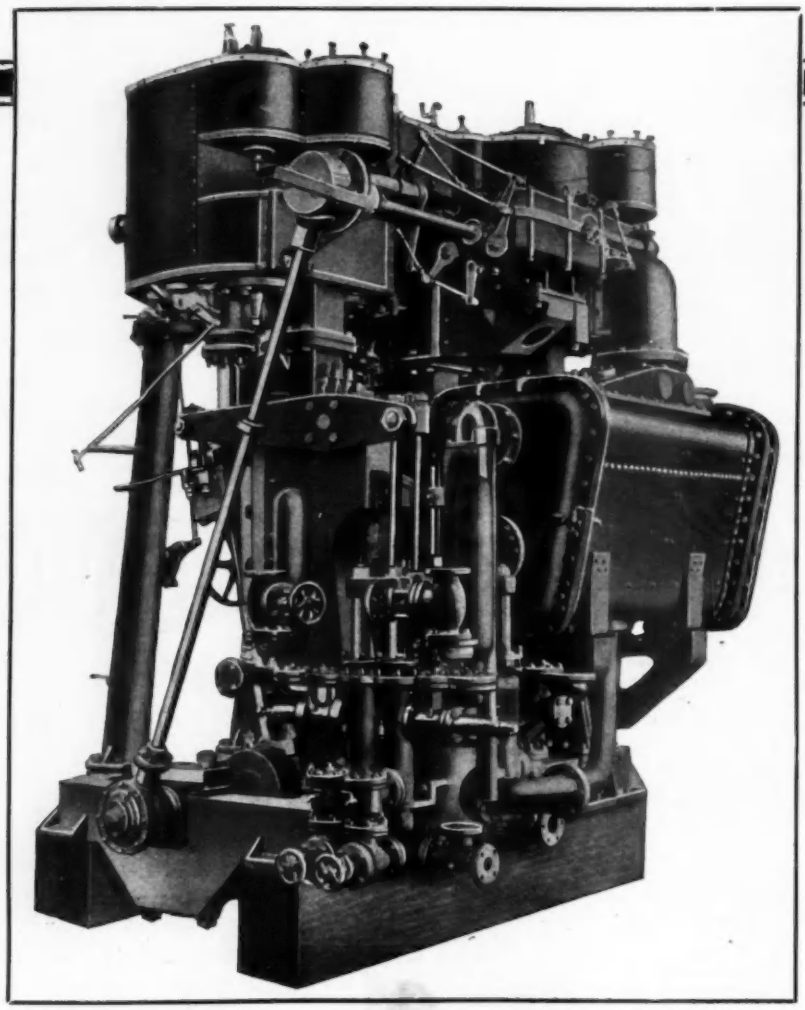

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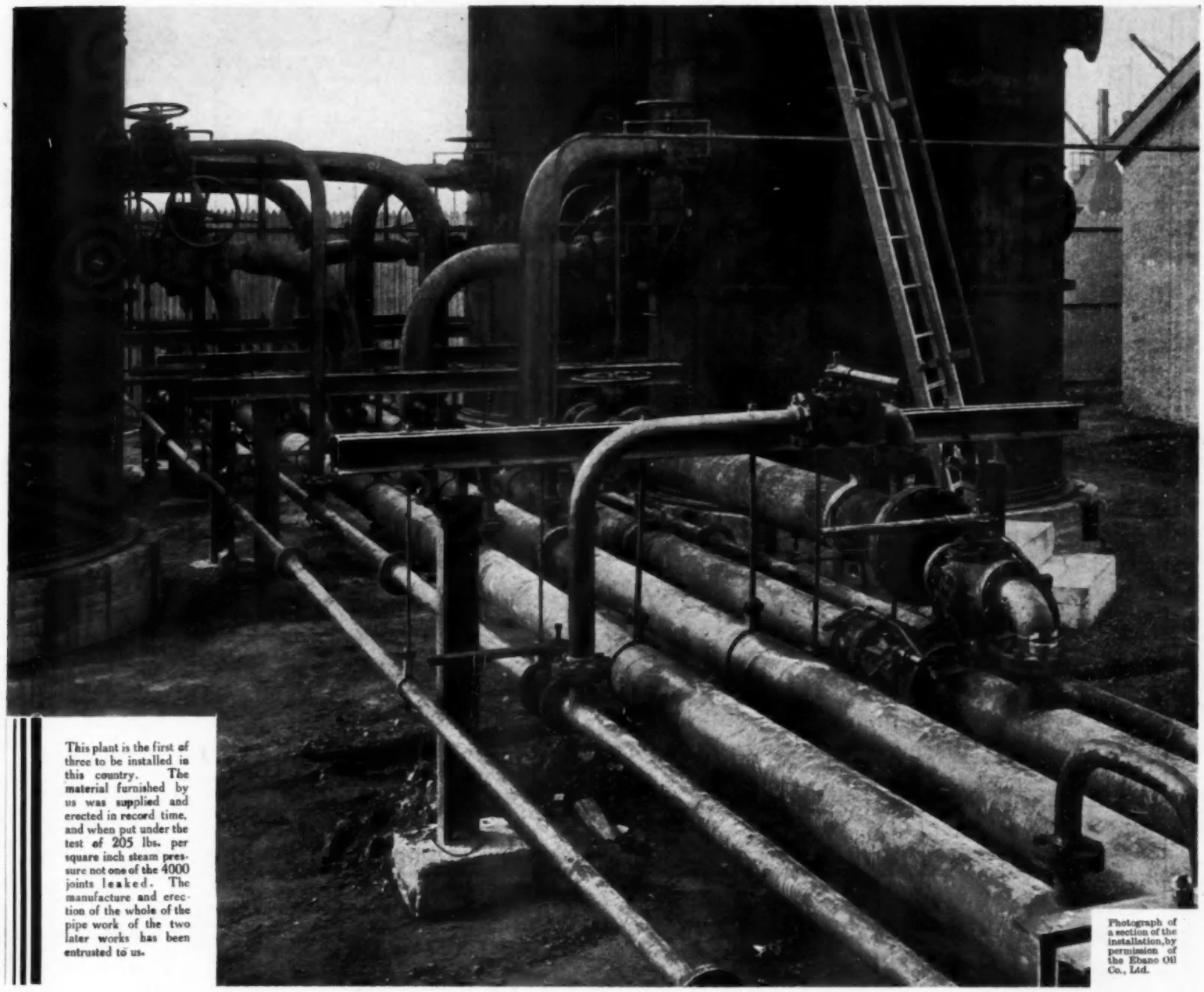

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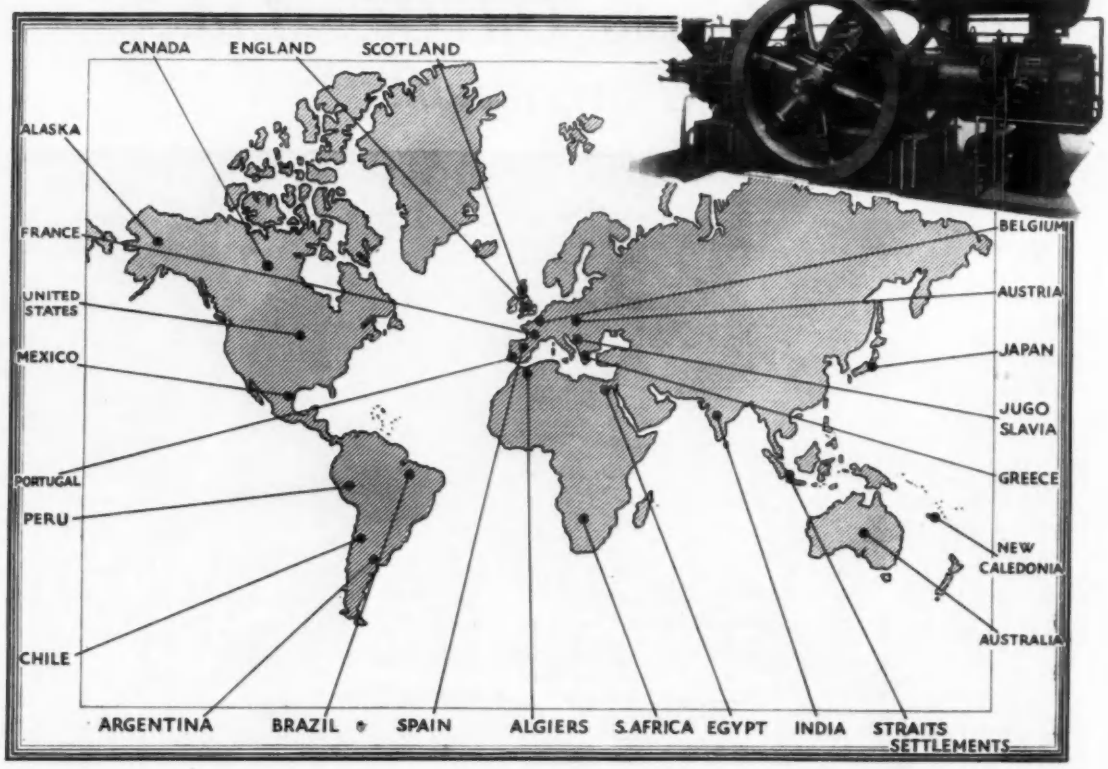

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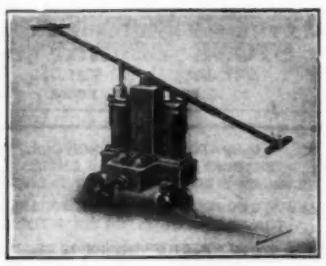

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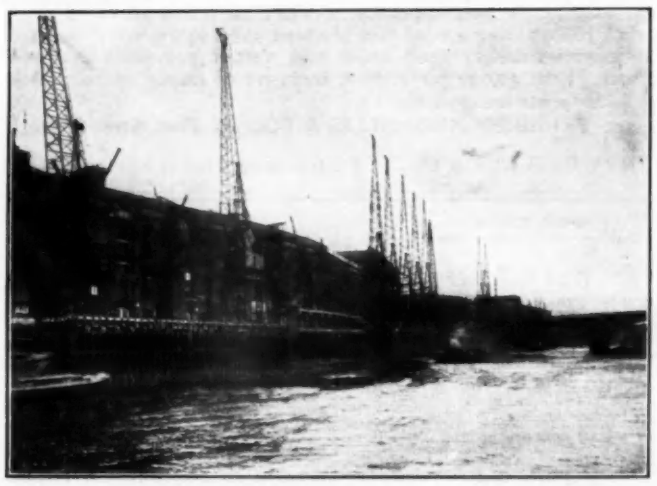

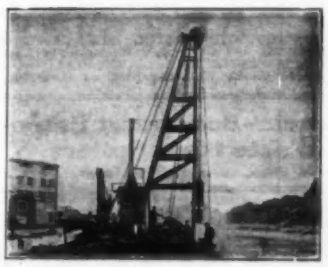

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